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ABSTRACT

This manual is designed to assist pest control operators to prepare for certification under the Michigan Pesticide Control Act of 1976. The primary focus of this publication is on home, institutional, and structural pest control. The ten sections included describe: (1) Insect control; (2) Rodent control; (3) Special situation pest control; (4) Safety; (5) Labeling service containers; (6) Disposal of pesticides; (7) Insect pests in buildings; (8) Insects of stored products and furnishings; (9) Arthropods other than insects; and (10) Vertebrate pests. Section seven discusses different types of insect pests in buildings such as cockroaches, crickets, earwigs, bugs, booklice, beetles, weevils, wasps, bees, mosquitoes, flies and fleas. A list of self-help questions and instructions for completing the questions are presented at the end of each section. (HM)

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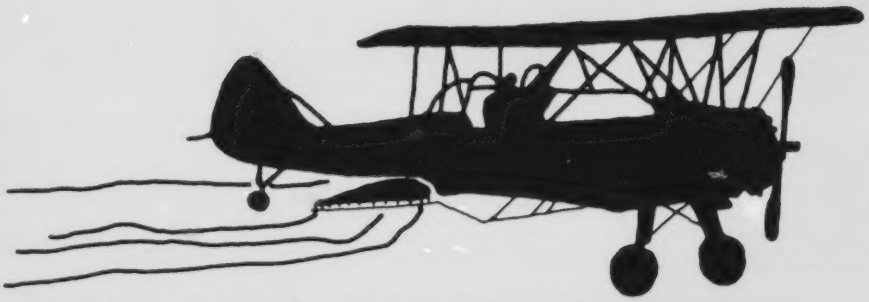

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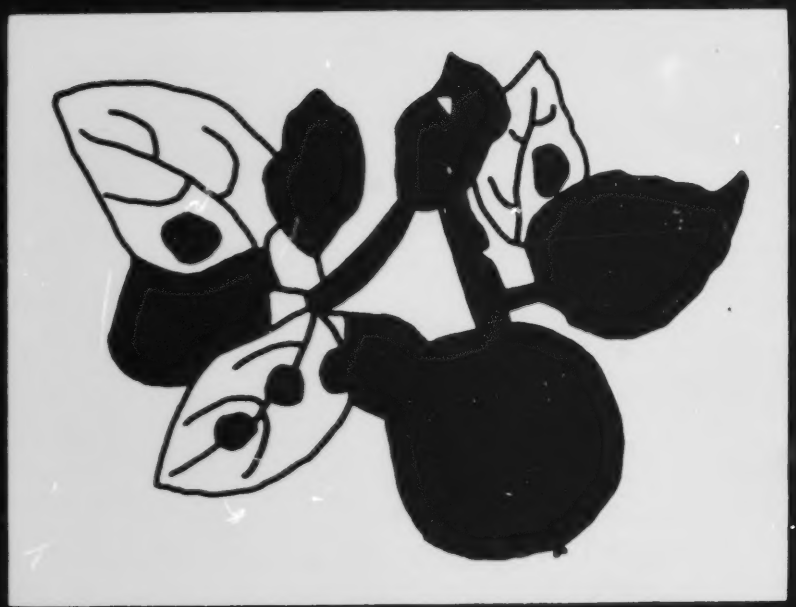
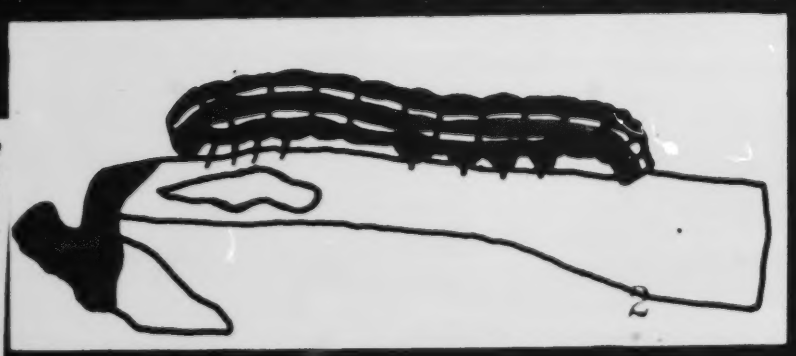
A MANUAL FOR COMMERCIAL APPLICATORS





SE 024 688

This manual was prepared to assist pest control operators to prepare for certification under the Michigan Pesticide Control Act of 1976. This manual was based on the National Pest Control Association's "Preparing for Applicator Certification—Vol. I, General and Household Pest Control," and is used with their permission.

A list of self-help questions and instructions for completing the questions are at the end of each section. If you encounter difficulties in using the manual, please consult your county agricultural extension agent or representative of the Michigan Department of Agriculture for assistance.

Some suggestions on studying the manual are:

1. Find a place and time for study where you will not be disturbed.
2. Read the entire manual through once to understand the scope and form of presentation of the material.
3. Then study one section of the manual at a time. You may want to underline important points in the manual or take written notes as you study the section.
4. Answer, in writing, the self-help questions at the end of each section. Instructions on how to use the self-help questions in your study are included with the questions. These questions are intended to aid you in your study and to help you evaluate your knowledge of the subject. As such, they are an important part of your study.
5. Reread the entire manual once again when you have finished studying all of its sections. Review with care any sections that you feel you do not fully understand.

This manual is intended to help you use pesticides effectively and safely when they are needed. We hope that you will review it occasionally to keep the material fresh in your mind.

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INSECT CONTROL

AEROSOL INSECTICIDES

Insecticidal aerosols are extremely fine mists produced by dispersing insecticides dissolved in liquid gases. As used indoors, aerosols may be either gas propelled or thermally released.

Gas Propelled Aerosols

Gas propelled aerosols are delivered from a special container containing an insecticide and a liquified gas (often along with a solvent) and are dispersed through a valve designed to deliver fine liquid particles containing the insecticide into some air space, as in a room. The particles may be compared to a fine mist or gas. They range in size from 0.1 to 50 microns.

There are three uses of aerosols for insect control indoors: (1) space treatments for quick knockdown and control of crawling and flying insects; (2) to cause crawling insects, such as cockroaches to be more active and to make greater contact with deposits of residual insecticides (aerosols alone are considered to be ineffective for the control of hidden crawling insects or those which may later be exposed); and (3) inspection tools for flushing crawling insects from their hiding places.

Storage and Handling

Insecticidal aerosols should always be stored in temperatures between 70°F. and 120°F. Higher temperatures can cause aerosol containers to explode, while lower temperatures can cause improper operation. Containers exposed to low temperatures should be placed in a warm room several hours before using. Such containers should not be subjected to temperatures above 120°F. to heat them. Lastly, aerosols should always be released into spaces having a temperature above 50°F.

Treatment of Large Spaces

When treating large spaces with insecticidal aerosols:

- The cubic feet of space to be treated should be calculated and the proper amount of insecticide to be used determined from the application rate on the label.

- Doors, windows, real fireplaces and other vents to the outside should be closed. Forced-air and gravity-airflow heating and/or air conditioning systems should be shut off.
- All occupants must be removed.
- All pets and other animals must be removed from the area to be treated. House plants should be covered or removed. Fish bowls and aquaria may be left in place if covered and aeration equipment turned off.
- Unwrapped or unpackaged food must be removed or placed in a closed refrigerator or container that will exclude aerosol particles.
- Food handling equipment, dishes, and other food contacting surfaces should be covered during treatment or washed after application.
- All entrances to area being treated should be locked.
- Total release types (valve is locked open to release all contents in absence of PCO) should be placed in a central location or a point near the greatest infestation. The aerosols should be distributed throughout the treated space if more than one is released. Also, some protective substance, such as newspaper, should be placed under the cannister so that the "fallout" of large droplets will not damage the surface upon which they rest.
- Aerosols having an oil base can cause staining. These should be held at a distance of three feet (or as stated on the label) from products, wallpaper, fabrics, clothes, polished and upholstered furniture.
- All pilot lights and other open flames must be extinguished when using total release type aerosols. Other aerosols should not be released within six feet of pilot lights unless the pilot lights are extinguished.
- An organic vapor respirator approved by the USDA, EPA or Bureau of Mines should be worn whenever releasing an aerosol. An exception may be made when actuating total release aerosols if the operator leaves the treated area immediately.
- The directions on the federal or state registered label should be followed to determine exposure period and necessary aeration time.

When you are using an aerosol for the purpose of activating crawling insects so they will make greater contact with residual deposits, the residual treatment should be applied first.

For use as inspection or flushing tools where the aerosol particles are directed into cracks and crevices:

1. Observe the temperature requirement listed above for storage and use.
2. The precautions listed above for treating large spaces need not be observed but:
   a. The aerosols should not be used near birds and pets; fish bowls and aquaria should be covered first.
   b. The aerosols should not be operated within six feet of open or exposed flames.
   c. An extension device attached to the nozzle should be considered to better direct the spray into cracks and crevices.

Thermal Aerosols (Fogs)

Thermal fogs are liquid particles in an airborne state with the particles ranging in diameter from 0.2 to 9 microns. They are produced by injecting oil-base liquid formulations on to a heated surface or into a heated air stream.

Since flammable liquids are often used in thermal fogging, certain safety factors must be considered. Atomization of low flash point, as well as, high flash point liquids, can result in the production of an oil-enriched atmosphere. Such an atmosphere is capable of propagating a flame similar to combustible solids in dust explosions. One gallon of kerosene will render 2,000 cubic feet of air explosive and a single spark can set it off. One gallon in 50,000 cubic feet is well below the lower explosive limit, but an open flame can ignite the oil and cause a fire.

Thermal fogs indoors may be used alone to control flying insects or in conjunction with other types of insecticidal application(s) for controlling crawling insects. Special precautions must be taken when thermal fogging is in process because of the high hazard to property and personnel.

Steps to be taken before fogging:

- The person responsible for the property to be treated should be provided with a list of instructions and precautions. This list should include the approximate time the building may be reoccupied following treatment, but should state that the building may not be reoccupied until warning signs are removed. Suitable arrangement should be made for re-lighting pilot lights.
- All pets and other animals must be removed. Living plants are sometimes damaged by oil droplets condensing on the leaves, but outdoor conditions may be more damaging. Covering the plants with paper will protect them, but those responsible for the plants should decide what action should be taken.
- All food should be removed from the building, or placed in a container which is so designed that insecticide vapors and fog particles cannot readily reach the food.
- All windows, fireplaces, outside doors, ventilators, and other openings leading to the outside or untreated areas should be closed or otherwise sealed off and all pilot lights and other open flames extinguished.
- Notify local fire department of location, date, time and duration of treatment, the chemical that will be used and whom to contact in case of emergency.
- When the fog generator is to be used within a building, study the area to be treated in order to note potential obstructions or hazards to the man who will fog and to plan a route within the building for fog application. In the case of large complex buildings, the operator may find it desirable to mark a route by means of tape on the floor or some other means.
- Place warning signs on all entrances of the building and secure the building. The signs should indicate that the building has been fogged, it should not be entered, and whom to contact in case of emergency.

Procedure for Fogging

1. When using a fog generator within a large building men should work in pairs and always be in sight of one another during actual fogging. When fogging single residence dwellings or similar sized spaces or when the operation takes place from outside the building, a man may work alone.

2. Whenever the operator is in a position which would allow the inhalation of vapors, he should wear an organic vapor respirator approved by the U. S. Bureau of Mines. This is usually necessary when using a fog generator within a large building.

3. A fire extinguisher of an appropriate type and size should be ready for use.

4. Only diluents approved by the fogging machine manufacturer should be used. The flash point should be no lower than that of kerosene and preferably at least 40°F. above the air temperature of the space to be fogged.

5. Start machine outdoors, whenever practical. Cold weather or fogging upper stories of multistoried buildings makes outdoor starting impractical. When starting indoors, the nozzle of the generator should have combustible materials no closer than 10 feet directly in front of it and the machine should not be placed on a combustible surface.

6. Adjust for "dry" fog (there should be no noticeable deposit on a surface 18 inches in front of the nozzle). The generator should be kept in proper adjustment during operations. Excessive temperatures may cause "cracking" of the insecticide fluid into highly flammable gases and vapors.

7. When using a portable generator within a building, begin fogging at the point or furthest from the exit and work towards the exit according to plan. Use caution to prevent the hot tip of the machine from contacting and damaging the structure or its contents.

8. Do not exceed the application rate of ONE GALLON OF FOGGING SOLUTION PER 50,000 CUBIC FEET OF SPACE. The application must be made so that concentrations higher than this do not occur in any area—especially in closets and other "enclosed" areas—or else explosive concentrations may result. (A concentration of two-thirds of a gallon per 50,000 cubic feet reduces visibility to two feet.)

9. Fog attic and crawl space when applicable, but do not exceed the application rate of one gallon of solution per 50,000 cubic feet of space. Accidental entry of heavy concentrates of outside fog into basements or crawl spaces through open windows must not be overlooked.

BUILDING SHOULD REMAIN CLOSED AND SECURED FOR A MINIMUM OF FOUR HOURS FOLLOWING TREATMENT.

Post-Fogging Procedure

The operator should open the building or arrange to have it opened, then all seals should be removed and the building ventilated. Ventilation should continue until it is determined that the building is safe for occupancy. Practical experience may indicate that a particular type of building requires a given number of hours to aerate and the operator can have someone else ventilate the building for a prescribed time.

Remove warning signs from entrances and be sure that arrangements have been made to reactivate all utilities.

DUST APPLICATIONS

Dust applications can be used as a total treatment for insect control, but they are more often used as a supplemental treatment. Dusts have several advantages over sprays: they penetrate cracks and crevices better, often have longer residual action, and an insect often picks up a lethal dose of insecticide upon one contact with a dust. Skill is required to apply dusts neatly, however, and they can be tracked or moved by wind currents. Dusts tend to cake in a wet or humid environment, which reduces their effectiveness. Heavy dust deposits are unsightly and may repel some pest insects.

PCO Uses

Crawling household pests such as roaches, silverfish and ants can be controlled with residual insecticides applied as dusts. Dusts are well suited to application into wall voids, cracks and a variety of similar hiding places which are not accessible to treatment by any other formulation. Pipes, tunnels

and conduits are readily treated by a dust; in this case the dust is best applied by introducing it into an already moving air stream. Dust may be applied around an area being protected so the insect pest will be forced to walk through this barrier to gain access to the property. A few craftsmen are skilled in a process called "lining" by which the dust is applied to vertical as well as horizontal concealed surfaces as at doorways to elevators, sliding doors, etc.

Some areas can be treated with dusts where sprays might be objectionable because of staining. Insecticides such as sodium fluoride and aerosols which remain active so long as they are dry are useful for treating difficult-to-reach harborages. In this case, the time required for careful and thorough treatment is justified by the extended period of control that can be expected. Pyrethrum dust not only kills some roaches, but it can be used to flush roaches from their hiding places so that residual sprays may be effectively applied.

Dusts may also be blown into concealed voids to control cluster and face flies and boxelder bugs. The dust is blown into the void through a natural opening or a small hole is drilled and the nozzle of the duster fitted into the hole

Dusts are useful and effective for the control of fleas, lice and ticks on animals. Sprays are messy and the animal may catch cold from being wet. For good reasons, PCO's should not apply any treatment to animals. Several commercially prepared dusts are available which can be sold for application by the owners of the pets and by veterinarians. The PCO can use certain dusts in treating bedding; but for treating premises such as homes, kennels, yards, etc., sprays are more effective and more practical than dusts.

Application Equipment

Dusters come in a variety of sizes and may be hand or power operated. The PCO will most commonly use a small hand duster. These dusters should have a fairly long narrow spout or nozzle to reach behind cabinets, etc., and to enable the operator to apply a small volume and control it. Experience and personal preference will determine which type of duster and which length and shape of nozzle is best for the work a particular serviceman does.

When only small amounts of dust are to be applied, a small camel's hair brush is useful. By dipping the brush in the dust, the dust can be applied very neatly and with practically no waste.

A small electric duster with a hopper capacity of a pound or less is desirable for blowing dusts into concealed voids. Larger units with motors like those on vacuum cleaners and with hoppers holding enough dust for an average job (one to five pounds) are better for treating attics and underareas.

Advantages and Limitations

Dusting is more convenient than spraying as there is no water to carry, pump, mix or store and the equipment is lighter, cheaper and easier to keep running. The small particles are easily carried by air currents and can be blown into tunnels, voids, cracks and crevices to treat areas inaccessible to sprays.

Limitations common to dusts are: (1) they are generally less acceptable than sprays because they may leave unsightly deposits and, (2) they are time-consuming to apply indoors.

For safe and effective handling:

- Only those dusts and concentrations which are federally registerd for the intended or a similar use should be applied.
- Dusts should be stored in a dry place or in moisture-proof containers to prevent caking.
- Dusts should not be applied in any place where there is possibility of food contamination by filtering downward, by movement as by air currents, sweeping, traffic or by transfer on containers or other materials.

When dusts are applied into cracks and crevices:

- Light pressure should be used on the application device to minimize dust particles floating in living areas.
- Only a thin film should be applied as heavy deposits may repel the target insects.
- The dust should be applied so it does not travel to any areas where it may present a hazard.

- Dust remaining on exposed surfaces should be cleaned up or brushed into the cracks.

When dusts are applied with high-volume or high-pressure equipment into such areas as attics and subfloor crawl spaces:

- Approved respirator or dust mask for the formulation used should be worn.
- Steps should be taken to avoid movement of dusts to undesirable areas by air currents. Fans, air conditioning and hot-air heating equipment should be shut off when necessary to accomplish this.
- If the dust is combustible, all flames and pilot lights should be extinguished and spark-producing equipment should be shut down in the area to be treated to prevent an explosion.

WETTABLE POWDERS

A wettable powder (also called a water-dispersible, water-dispensable or sprayable powder) is an insecticidal formulation especially designed to be used as a suspension in water. This means the tiny particles of the powder are dispersed (suspended) throughout the water, but they do not dissolve to form a solution. The suspension is applied as a spray to horizontal or vertical surfaces so as to leave a residual deposit.

Advantages and Disadvantages

Because they lack solvents, wettable powders will not soften or dissolve such materials as asphalt tile or gaskets and hoses on sprayers. They leave very effective residues on absorptive and porous surfaces such as unfinished wood, brick and concrete. Oils and emulsions soak into these materials and draw the toxicant in with them. Although the water of a suspension may soak in, the particles of wettable powder bearing the toxicant remain on the surface to provide an effective residue.

Staining is one of the greatest disadvantages of wettable powders and related formulations. Because these are water base sprays, materials which will water stain should not be treated unless the stain will not be objectionable or noticeable. Colored deposits are also left on treated surfaces. These

deposits are formed by the particles in suspension and will be the color of the powder (usually white).

Suspensions are abrasive and wear out nozzles and pumps more rapidly than do other types of sprays. Suspensions require agitation and cannot be used for fogging.

Methods and Precautions

It is important to break up all lumps when preparing wettable powder suspensions. The most satisfactory method is to use a separate watertight container in which to place the desired amount of powder. Add a small amount of water and stir this well to make a paste or slurry, breaking up any lumps which remain. Pour half of the necessary water into the sprayer tank and add the paste to it, mix well, then add the rest of the water.

Suspensions require agitation, so if your sprayer does not have an agitator (most hand sprayers don't), shake the sprayer vigorously and repeat this at least every 15 minutes. This is important. Many poor control jobs can be traced back to insufficient agitation during application. Do not permit the suspension to settle out. Some materials do not resuspend easily.

These sprays should be applied just to the point of runoff, but no more. Continued spraying after this point results in a sloppy job, wastes money and actually reduces the amount of deposit left.

Be wary of mixing two or more wettable powders together. Some wetting agents are incompatible and you may end up with a big lump of insecticide on the bottom of the sprayer or most of it floating on the top.

MISTING—INDOORS

Misting is defined as the dispersion of liquid particles containing an insecticide into space by mechanical means.

Specifically excluded is thermal fogging, in which the liquid is heated and aersols applied from pressurized cylinders.

Mists can be dispersed using oil or water as a base. Oil-base mists can be ignited by an open flame although the explosion hazard is not as great as that of thermal fogs. Some practices differ for use on oil- and water-base mists.

Precautions in Application

- Only insecticides registered by a federal or state agency for indoor space application should be used. Residual insecticides should not be used as mists unless specifically registered for such use.
- All pets and other animals must be removed from the area to be treated. Fish bowls and aquaria may be left in place if covered and aeration equipment is turned off.
- All food must be removed from the room being treated or placed in containers that will exclude mist particles. If DDVP is being used, the containers should be sealed glass or metal.
- An approved organic vapor respirator should be worn whenever the machine is operating under conditions which might cause inhalation of the mist of vapor.
- Misting equipment left operating unattended should have a time switch set to shut off the mister at a predetermined time to avoid the application of too much mist. Excessive amounts may cause an undesirable film on furnishings and floor tile, resulting in stains or other damage.
- The temperature of the space to be treated should be above $50^{\circ}F$.
- The treated space should remain closed for at least 15 minutes and preferably for two hours following misting for best results against flying insects.
- A careful plan should be followed that will reduce to a minimum possible exposure of the operator to the mist when a portable misting machine is used within a building.
- The building (or the treated space) should be ventilated for at least 30 minutes before reoccupancy is allowed. The ventilation may be carried out by a responsible person other than the operator if that person has received proper instruction on how to do it.

The mist should be used in conjunction with a residual treatment for long-lasting control of crawling insects. The mist should be applied following the residual application.

The following should be observed when using oil-base materials:

- All pilot lights and other open flames in the area to be treated must be extinguished.
- Only those diluents approved by the misting machine manufacturer should be used.
- Living plants in the area to be treated should be removed or covered. Living plants are sometimes damaged by oil droplets condensing on the leaves. Outdoor conditions may be more damaging. Covering the plants with paper will protect them. Those responsible for the plants should decide what action should be taken.
- A fire extinguisher of an appropriate type and size should be ready for use.
- Care should be used in areas subject to wetting as an oil film can cause a floor, especially a wet one, to be very slippery.

The following should be observed when misting the entire interior of a building:

- All windows, fireplaces, outside doors, ventilators, and other openings leading to the outside should be closed or sealed.
- Warning signs should be placed on all entrances, and the building secured. The signs should indicate that the building has been misted, that it should not be entered, and whom to contact in emergencies.
- Men should work in pairs and always in sight of one another during the actual misting of a large building if the machine is operated from indoors. The operator may work alone when misting single residence dwellings or similiar sized spaces or when operating from outside the building.

ULV—INDOORS

ULV (ultra low volume) applications of insecticides can be made indoors using recently developed equipment. You should only use insecticide formulations federally registered for this application. Two such products are now available. The use of ULV applications appears to offer advantages over conventional fog, mist, and aerosol applications for certain situations, but it has some of the same limitations.

ULV techniques depend upon breaking a liquid insecticide concentrate into small droplets of uniform size. Research data indicate that insecticide droplets of 5-10 microns in diameter are most efficient for many types of insect control. In practice, this range seems to be most efficient for controlling cockroaches also. Larger droplets "fall out" too quickly, wetting surfaces unnecessarily and penetrating cracks and crevices poorly. Smaller droplets tend to go around objects (including insects) too easily rather than hitting and sticking (impinging) upon them. ULV machines can produce the desired droplet sizes and keep the size relatively uniform. Misting machines produce droplets of 10 to 80 microns, pressurized aerosols produce droplets of 0.1 to 50 microns, and thermal foggers produce droplets of 0.2 to 9 microns. Although conventional equipment can produce some droplets of the proper size, only a small percentage are of the desired size. Data show that ULV equipment, if adjusted and operated properly, can produce nearly all (+98 percent) droplets of 1 to 15 microns.

ULV applications Comparing to other methods of space treating: (1) Less oil is needed. ULV machines break up concentrates into the desired droplet sizes. This also reduces explosion and staining hazards. (2) More active ingredient is used. This increases the amount of insecticide needed to treat a given area. (3) Treatment time is less.

Not a Residual Treatment

ULV treatments should be used to supplement a residual treatment to control crawling insects. No space treatment, ULV or "conventional," is effective for controlling cockroaches or other crawling insects when used alone. This treatment is useful in flushing out hiding insects.

ULV treatments can be made only during shutdown periods or when area is unoccupied.

If ULV equipment is used to kill flying insects, use it in a manner similar to conventional space-treating equipment. After applying the insecticide, the area should be closed for one hour.

When treating for cockroaches and other crawling insects, you should first make a residual treatment. The ULV treatment provides great flushing action but cockroaches must be exposed to the droplets for at least 10 minutes to receive a lethal dose. Although the droplets apparently penetrate cracks and crevices better than those produced by conventional equipment, good kill is obtained only if the cockroaches are flushed out. Some cockroaches apparently are driven deeper into voids and the residual treatment is necessary for good control. Control is increased if air currents are created to carry more droplets into cockroach harborages.

The droplets will remain airborne for up to six hours if there is no ventilation. The treated area should be closed for this period for maximum effectiveness.

Respirator and goggles must be worn by operators.

The ULV droplets are so small they are readily inhaled. Oil droplets without insecticide of this size could be hazardous if inhaled.

Only one-half ounce of oil-base insecticide is applied per 1,000 cubic feet. However, there may be a residue left on counter tops and similar surfaces, especially if they are greasy or dirty. Grease apparently attracts the droplets. The residue is not readily apparent, but anyone looking for it can feel and see it. All food-contacting surfaces should be covered during the application or washed afterwards.

Food should not be exposed to the treatment. All foodstuffs must be covered or removed during the treatment. Ventilate the treated area before returning foodstuffs if the area was closed for less than six hours. The insecticide droplets will have settled out within six hours and ventilation is unnecessary if the treatment was made more than six hours earlier.

To the extent possible, move the application equipment during treating and direct the insecticide towards and into cracks, crevices and other hiding places. Directing large equipment towards walls or other surfaces creates air currents which help carry droplets into harborages.

Keep liquid concentrates and aerosols at room temperatures to ensure proper droplet sizes. Cold materials tend to produce larger droplets, which result in oil slicks and decreased penetration of harborages.

Start gasoline engines outdoors to reduce smoke indoors.

Keep mufflers and exhaust pipes of gasoline engines away from combustible materials.

The gasoline engines are directly or indirectly causing several problems:

- Carbon monoxide is a potential hazard if the engine is run for a long period where its exhaust may concentrate in a dead space.
- The haze, fog, or otherwise visual filling of the treated space is often caused by the engine rather than the insecticide.
- Slow running speeds create droplets too large which reduces effectiveness and increases the potential for undesirable oil deposits. Slow speeds are caused by improperly tuned engines, improper gas-oil mixtures, and high altitudes.

ULV applications have set off smoke-alarm systems. If such a system is present in a building to be treated, have it turned off or cover the sensing units with plastic bags.

Fire and explosion hazard is lower than that of foggers, but equal to that of misters and aerosols. Therefore, extinguish all flames.

INSECT BAITS

An insecticidal bait is a combination of an attractant and a toxicant. Success with an insecticidal bait depends upon attractiveness, palatability, toxicity, speed of action, stability, physical condition, and time, place, and method of exposure.

All toxicants used to prepare baits and all commercially prepared baits used should be registered for the intended or similar use. They should be stored and transported in closed containers to prevent them from picking up undesirable odors or tastes from other chemicals.

Baits should be distributed so that all of the insects to be attracted are likely to contact them. In the case of trail-laying ants, a few placements will often suffice. Many placements no more than a few inches apart are needed for controlling German cockroaches. A familiarity with the pest's behavior is important.

Baits should be distributed so as to prevent children, pets, or wildlife from reaching them. This may be accomplished by:

- Placing them in protected locations such as cracks and crevices, wall voids, behind or under fixtures, and enclosed crawlspaces.
- Placing them in bait containers designed to prevent children or animals from reaching them.
- Scattering pellet baits outdoors where they will sift downward out of sight into turf, vegetation, or mulches.

Baits should be distributed in a manner that prevents contamination of foodstuffs by:

- Placing pellet and crevice type baits only at floor level.
- Avoiding the placement of paste and jelly type baits directly above exposed foods or food-contacting surfaces. Heat may cause such baits to run and drip and should be considered when choosing placements.

NONRESIDUAL INSECTICIDES

Nonresidual insecticides are those products applied to obtain insecticidal effects only during the time of treatment and are applied either as space treatments or contact treatments. Space treatment is the dispersal of insecticides into the air by foggers, misters, aerosol devices or vapor dispensers for control of flying insects and exposed crawling insects. Contact treatment is the application of a wet spray for immediate insecticidal effect.

When using nonresidual insecticides see procedures for aerosol ULV gas propelled and ULV aerosol, thermal (fogging) misting.

Residual insecticides are those products applied to obtain insecticidal effects lasting several hours or longer and are applied as general, spot, or crack and crevice treatments. (1) General treatment is application to broad expanses of surfaces such as walls, floors, and ceilings or as an outside treatment. (2) Spot treatment is application to limited areas on which insects are likely to occur, but which will not be in contact with food or utensils and will not ordinarily be contacted by workers. These areas may occur on floors, walls, and bases or undersides of equipment. For this purpose, a "spot" will not exceed two square feet. (3) Crack and crevice treatment is application of small amounts of insecticides into cracks and crevices in which insects hide or through which they may enter the building. Such openings commonly occur at expansion joints, between different elements of construction, and between equipment and floors. These openings may lead to voids such as hollow walls, equipment legs and bases, conduits, motor housings, junction or switch boxes.

SELF-HELP QUESTIONS ON INSECT CONTROL

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. Aerosol insecticides can be used in the following three ways:

2. What are the proper safe storage temperatures for aerosol?

3. A thermal fog differs from a gas aerosol in what characteristics?

4. What are the safety factors to keep in mind when releasing aerosol insecticide both to the applicator and the area being serviced?

5. Can a building be safely entered after 4 hours following fog application, and where can this information and necessary aeration time be found?

6. Give the advantages and disadvantages of applying dusts rather than sprays indoors:

7. What are the safety precautions to keep in mind when dusting indoors?

8. Explain the agitation necessary, the amount of spray to be applied, and material incompatibility when suspension sprays are applied:

9. Name two main disadvantages often found when suspension sprays are applied:

10. Define the term "misting":

11. Can all residual insecticides be used in misting if labeled for suspension spraying?

12. What are the precautions to consider when applying oil based misting materials?

13. U.L.V. applications differ from other methods of space treating by what main factors?

14. Are U.L.V treatments effective as residual treatments and what safety precautions are necessary with their use?

15. How should insecticidal baits be applied and what are the hazards?

16. Define the terms "nonresidual" and "residual" insecticides and explain their differences?

RODENT CONTROL

RODENT BAITS

Bait Selection

Using the proper bait will often have more bearing on your results than will choice of rodenticide and bait placement. You should consider the species of rodent when choosing a bait.

Rats are creatures of habit and tend to feed on things familiar to them. They initially avoid new foods. This means that in many cases baiting with food rats are eating will bring good results.

As a general rule, Norway rats prefer meat and fish; roof rats prefer fruits and vegetables. With this in mind you may be able to lure rats away from their usual food, especially if prebaiting is practiced. Water baits work effectively with both species, when used in dry environments.

House mice are nibblers and like to try new foods. Therefore, using baits quite different from their usual food source often works well on mice. NPCA-supported research at Southern Illinois University shows that prunes, pineapples, and the juices of both are favorites of house mice. Water baits are seldom practical.

All bait materials should be fresh. Moldy, rotted, or dried-out baits are poorly accepted by rats and mice. Baits must not taste or smell of other chemicals. If you transport baits in a vehicle with insecticides, keep the baits in airtight containers.

Food baits should be crumb sized or a sloppy paste to reduce the possibility of rodents carrying baits to other areas. All recognizable foods should be diced, rolled or otherwise made unrecognizable.

If you mix your own baits, follow the directions on the USDA registered label for the rodenticide used. Generally, the rodenticide should be mixed with the liquid or moist part of the bait formula first, and this mixture blended with the dry ingredients. Baits should be well mixed so that the toxicant is distributed evenly throughout.

Bait Placement

When practical, baiting should be done in late afternoon. Rats and mice most often look for food at dusk. Baits stand a better chance of being fresh at dusk if placed in late afternoon.

Baits must be placed so that they are not readily accessible to other animals and children. You may have to use bait boxes, but not throw bags, to achieve this in some areas.

Baits should be placed where rodents will find them. Rats usually feed in one place so a relatively few bait stations will often suffice. Baits should be placed under cover, in burrows and along walls. Mice will feed in many places during a night and they will not travel great distances. Many placements are needed, and they should not be more than 10 feet apart when baiting for mice.

The amount of bait needed depends upon the rodent species, the size of the infestation and the toxicant. There should be more than enough bait to feed all rodents present. If all baits are eaten the first night, then not enough bait was put out. Teaspoon-sized placements will suffice for mice and tablespoon-sized placements for rats when the account is serviced daily. Larger amounts are needed when the account is serviced less frequently, especially when anti-coagulants are used.

Prebaiting

Prebaiting is the exposure of unpoisoned bait for several nights prior to using poisoned bait. The bait material must be the same during both periods. Prebaiting should be done for two nights to a week. This will accustom rats to feeding on a certain food at a certain place each night. This overcomes rats' natural reaction of avoiding new foods and bait shyness in rats previously poisoned. Through prebaiting, you can estimate the amount of poisoned bait needed and where it should be placed.

Prebaiting is useful for controlling "difficult" rats with quick-acting rodenticides. Prebaiting is too costly for large-scale or routine use. It is unnecessary when using anticoagulants and is generally not worthwhile for house mouse control.

Anticoagulant Rodenticides

The anticoagulant rodenticides, which include Warfarin, Fumarin, Pival, and PMP, act by disrupting the normal blood clotting mechanisms. Although the anticoagulants are considered relatively safe, these rodenticides must still be used in such a manner as to protect the public and domestic animals. They are available both as dry powders, which are to be mixed with solid baits, or as salts, which are to be mixed with water to produce liquid baits.

Anticoagulants may be used in homes and business establishments with the following precautions:

- Present all poisoned baits as conveniently and attractively to rodents as is consistent with safety, and in such a manner so as to preclude contamination of food or foodstuffs. Exposure within a building should be at floor level.
- Where anticoagulant baits are used indoors in areas where the public, children, and domestic animals are present, the bait should be kept in a covered rodent bait station. A warning lable must be affixed to the container. Open bait trays may be used indoors if placed in areas not readily accessible to the public, children, or domestic animals.
- When baiting out doors, place all baits into burrows, tunnels, deep into holes, or in covered rodent bait stations. Grain baits coated with anticoagulants and embedded in paraffin may be used in wet condition.
- A sufficient amount of anticoagulant food or water bait should be set out at one station where rodents are accustomed to feeding. Assure an uninterrupted supply of bait for a period of not less than 15 days and continue baiting until all signs of feeding have stopped.
- All dry baits should be inspected at least once per month and replaced with fresh baits if insect infested, moldy, or otherwise unattractive to rodents. Baits should be replenished as necessary to ensure an adequate food supply for rodents.
- Insect infestation of cereal type rodent baits containing anticoagulants should be prevented so that bait acceptability remains good and the treated premises do not become insect infested. The probability of insect infestation can be minimized by fumigating the bait, storing it in an insect-tight container prior to use, and removing and destroying exposed

baits at least once a month.

TYPES OF RODENTICIDES

Antu

Antu is a relatively safe, quick-acting poison which can inexpensively accomplish reduction of Norway rat populations. Antu is not effective against mice or roof rats. It is less effective against the young than the adult Norway rat. Most other animals are not susceptible to Antu, but pigs, cats, dogs, and horses are susceptible. It is not absorbed through the skin. It may be used as a bait or as a tracking powder. Rodents killed with Antu present no secondary poisoning hazard but should be recovered for sanitary reasons.

Antu should be used no more often than once every six months in or on a premise because rats develop a tolerance and bait shyness to this rodenticide. After initial reduction of a rat population, Antu should be replaced with another rodenticide or method.

Antu can be mixed with any food acceptable to rats such as ground meat, bacon, fish, grain, fruits, or vegetables. When using baits, the following precautions must be followed:

1. Outdoors, baits may be placed in burrows, tunnels, beneath objects, or in protected bait stations.
2. Indoors, baits may be placed in open rodent bait trays if children or pets don't have access to the baited areas.

Antu may be used as a tracking powder. If a concentrate is used, dilute it with talc, flour, or other inert ingredients to prepare a tracking powder.

Arsenic Trioxide

Arsenic trioxide is a toxic rodenticide that is effective against Norway rats, roof rats, and mice. Ingestion of sublethal amounts may result in development of a tolerance. It is not absorbed through the skin and there is no secondary poisoning hazard. It should be used as a short-term specific corrective agent and not as a routine maintenance rodenticide.

Because of arsenic trioxide's toxicity, the following methods and precautions should be adhered to in its use:

- When arsenic trioxide is dusted onto solid foods, these foods must be diced, rolled or crushed to render them unrecognizable as human foods.
- Persons preparing or placing baits should wear disposable gloves and wash their hands after any handling operation. They should not smoke or eat until their hands have been washed.
- When preparing arsenic trioxide baits, a respirator must be worn to prevent inhalation of the dust.
- PCO's utilizing this agent should collect all unused baits and all bait containers at the completion of the program. Baits should be buried or burned. Bait containers should be burned or buried if they are not to be reused. Reusable containers should be washed to prevent buildup of residues. Carcass retrieval is unnecessary for safety, but should be considered for good sanitation and public relations.

Phosphorus

Phosphorus is an extremely toxic, quick-acting rodenticide that is effective against both Norway and the roof rat. Its strong odor is believed to make it unattractive to house mice. Phosphorus possesses one advantage over several of the other more toxic rodenticides, in that it possesses a minimal hazard of secondary poisoning. This is a result of the material being oxidized in the stomach of the rat. This rodenticide is not recommended as a routine maintenance rodenticide, but rather as a short-term specific corrective agent.

Because of its extreme toxicity, the following methods and precautions should be adhered to in the use of phosphorus paste:

- Phosphorus paste may only be used when less hazardous materials cannot be expected to provide adequate control in a given situation. This shall be determined after a careful inspection has been made of property to be treated.
- Phosphorus paste must never be utilized in any areas accessible to children, poultry, pets, or domesticated animals or used in residences.
- Phosphorus paste must never be used on a readily recognizable food material such as whole bread slices or cookies. It can be utilized on small squares of bread cut into maximum sizes of one-half inch.

- The final bait form should be formulated only when needed and all personnel handling the paste should wear rubber gloves and be instruced to carefully wash their hands after handling operation. Personnel should be instructed not to smoke or eat during the performance of any of these activities.
- Finished baits should not be "scattered" or "broadcast," but carefully placed in furrows, which are then closed, or other places inaccessible or, if indicated, in safety rodent bait stations.

Red Squill

Red squill is one of the safer rodenticides available, approaching the anticoagulants in safety. The characteristics that make it relatively safe are: a bitter taste which is objectionable to man and many domestic animals; and its strong emetic action which causes prompt vomiting.

Because of its strong taste, red squill is effective against the Norway rat only. Even in the Norway rat, a sublethal dose will cause severe bait shyness; therefore, more bait should be used than is likely to be consumed so that a lethal dose is available to the entire population on the first feeding.

Generally, the most effective use of red squill is for a quick reduction of a rat population over a short period of time. It is not suited for continued use because many of the surviving rats will be bait shy. It is suggested that it not be used more often than every six months against any given rat population. Ground meat or fish are the most attractive baits, but cereals are adequate in most cases. Prebaiting will increase effectiveness.

Because red squill is irritating to the skin, it is advisable to wear rubber gloves when preparing or handling baits.

It may be used with caution in homes, commercial buildings and outdoors.

It should always be placed out of reach of children, domestic animals and irresponsible persons. If necessary, covered rodent bait stations should be used.

Since red squill does not pose a secondary poisoning hazard, dead rats need only be recovered and disposed of for sanitary reasons.

Sodium Fluoroacetate (1080)

Sodium fluoracetate is an extremely toxic rodenticide which must be used with extreme caution. It is tasteless, odorless, water soluble, and usually works very fast. The qualities that make it effective are the same ones that make sodium fluoroacetate hazardous. Because there is no known antidote and there is a secondary poisoning hazard, many special precautions must be followed in order to use this rodenticide safely. Good practice in the use of sodium fluoroacetate requires the PCO to comply with instructions on labels, manuals, and agreements provided by the manufacturer and to give special attention to the precautions listed below. These precautions apply to work done by pest control operators in controlling commensal rodents (Norway rats, roof rats, and house mice).

Sodium fluoroacetate may be used only when less hazardous materials cannot be expected to provide adequate control in a given situation. This is to be determined only after a careful inspection is made of the property to be treated, and after a thorough evaluation of the rodent infestatation as related to the environment and the colony history.

Sodium fluoroacetate shall not be used in or around residences or places inhabited or frequented by children, irresponsible persons and/or pets.

Sodium fluoracetate may be used in commercial, business and military establishment, including food processing plants and on ships if the following precautions can be followed.

- All containers of sodium fluoroacetate must be stored in a locked room or cabinet on the PCO's premises. Water solutions of sodium fluoroacetate must be transported to the job site only in unbreakable containers such as rubber or plastic that are properly labeled and the vehicle in which they are carried must be kept locked when unattended. On the job, sodium fluoracetate containers must be kept within sight of the man using them.
- Sodium fluoroacetate must be exposed only as a water solution except as noted below. Avoid an increase due to evaporation of water from bait containers.
- All sodium fluoroacetate water solutions must be colored with an acceptable black dye.

- Exposure of sodium fluoroacetate solutions within a building must be only at floor level.
- Sodium fluoroacetate may be exposed in unprotected containers only when the building or portions of buildings to be treated is under complete control of the PCO during the entire exposure period so that no person, pet, or domestic animal can enter the treated area.
- Containers for open exposure of sodium fluoroacetate must be conspicuously labeled specially designed cups, glass coasters, or other containers that will not permit seepage for a period of three days. Such containers must have a flat base and their diameter must be at least three times their height. The containers must be designed so that they cannot be readily carried or overturned by commensal rodents.
- Bait boxes for protected exposure of sodium fluoroacetate water solutions must be sturdily built and locked or otherwise securely closed so that the rodenticide is not accessible to humans, pets, or domestic animals. They must be designed so as to prevent ready access to the poison by pets and persons other than the operator. These boxes must be leakproof, or equipped for absorbing any sodium fluoroacetate solution spilled within them. These boxes must bear a label with the words "Sodium Fluoroacetate Poison," a skull and crossbones. Dispensers for use in the bait boxes can be of different proportions than those given above if designed so that their contents will not spill out if knocked over.
- Sodium fluoroacetate may be exposed in buildings not under PCO's complete control only if placed in safety rodent bait stations securely fastened to the floor or ground and all personnel in the area are notified of the use of sodium fluoroacetate and its hazards. It is desirable to have an official who is responsible for all personnel in the area sign a statement that all such personnel have been notified of the use and hazard of sodium fluoroacetate.
- When solutions are exposed continuously, old solutions should be removed, the containers cleaned, and fresh solutions added at each servicing. Otherwise, the concentration may become excessive due to evaporation.

- For each exposure of sodium fluoroacetate solution, a diagram of the property shall be made and each solution placement located thereon at a numbered location. A copy of the diagram should be left with a person responsible for the treated property.

- At the close of operations, all unused water solutions and containers must be recovered and a diligent search made for all poisoned animals. When solutions are exposed continuously, all poisoned animals must be picked up daily by the operator or by a person responsible to the owner of the treated property and who has been instructed by the PCO regarding the hazards of sodium fluoroacetate. Personnel should be instructed to wear rubber gloves during these operations, to carefully wash their hands afterwards, and not to smoke or eat before washing.

- All unused sodium fluoroacetate solutions and all disposable solution containers and poisoned animals must be disposed of, preferably by incineration, or by burying at least three feet below the surface of the soil in an isolated location. In large cities, solutions, containers, and dead animals should be taken to the appropriate city facility and the operator should see to it that they are incinerated or properly buried. They should not be dumped into sewers or placed in refuse containers to be picked up by regular garbage disposal teams. The responsibility for disposal of carcasses may be delegated to others when sodium fluoroacetate is exposed continuously. Water solutions of sodium fluoroacetate should be scattered on large amounts of absorbent paper (such as newspaper) before being incinerated. Glass or other durable containers for individual placements may be washed and reused, but they must be identified for this use only.

Records of each use of sodium fluoroacetate water solutions should be maintained for at least a year. Records must show: (1) Date of exposure; (2) address and description of exposure site; (3) diagram of placements; (4) an explanation of any difference between the number of baits exposed and recovered; (5) name and address of the person or persons responsible for the exposure of baits and the recovery of baits and dead animals.

Sodium fluoroacetate may be exposed in a food (nonwater) in concentrations not to exceed the manufacturer's recommendations in dumps and burrows if the following conditions are met:

1. All precautions as used for sodium fluoroacetate water solutions must be followed except it is unnecessary to use a bait container.
2. The bait base must be of a dry crumbly particulate type of a thin paste so that the bait cannot be readily carried to other areas by rodents.
3. The sodium fluoroacetate must be thoroughly mixed with the bait. The toxicant may be dissolved in a small amount of water blended in a dry form with a small amount of one of the bait ingredients to facilitate mixing.
4. The bait must be placed in such a manner that it will not readily be accessible to birds, desirable animals, or the public. When placed in burrows, the bait should be put far enough into the burrow so that domestic animals cannot reach it readily. Bait applied to dumps should be placed beneath objects, in containers, or into holes so that it is inaccessible.
5. Appropriate warning cards must be conspicuously displayed in adequate numbers whenever sodium fluoroacetate baits are used on public property or on private property readily accessible to the public. There is no need to post private property not readily accessible to the public.
6. If baits are placed in burrows or in accessible spots on dumps, there is no need to retrieve them. Retrievable baits that constitute a hazard must be destroyed. If a dump is to be burned or filled, it is desirable to bait a day or two prior to this so that hazard from remaining baits and dead rodents is further reduced.
7. Maintain a record of each bait application for at least a year. The record should show the application date and the address and description of the application site.

Strychnine

Strychnine is an odorless, colorless crystalline material with an extremely bitter taste. It is very fast acting and extremely toxic. There is a well-documented secondary hazard to dogs, cats and wild carnivores.

Strychnine is most often used for the control of house mice. It is not effective in rat control because it is too rapid in effect. Individual rats will reject the poison and populations will become bait shy.

Strychnine normally should be used only on grain baits to minimize hazards to dogs and carnivorous wildlife. Exceptions can be made in the control of certain native rodents, i.e., porcupines.

This rodenticide is for use as a short-term, single-dose corrective agent. Strychnine on wheat, hulled seeds, steam-crushed oats, or cracked corn may be used for house mouse control on a limited temporary basis. It should never form the backbone of a control program for house mice. It normally should be used after a good sanitation clean up. Good grade anticoagulant baits should precede a sanitation clean up. This allows the strychnine to be most effective against displaced or disrupted remnant populations.

Mixing strychnine baits requires skill, care and experience. It is recommended that those persons who are not skilled purchase supplies from established sources.

When placing strychnine baits in structures placement should be governed by the purpose of the structure and the activity of the people therein. Strychnine baits must not be used where there is any likelihood that children can reach them. They should not be used where they might contaminate food, milk, feed stuffs, cosmetics, drugs or other items for human or animal consumption. They can be used in wall voids, or in safety rodent bait stations in nonproduction areas of food plants or warehouses for house mice, IF safer materials will not suffice for the immediate needs. Placement should always be at floor level.

Bait trays or bait stations should always be marked with skull and crossbones and the word "poison." It is desirable to notify the building manager or plant operator that strychnine is to be used on the premises.

Bait placements should be mapped or annotated in records as to location.

Zinc Phosphide

Zinc phosphide is a toxic rodenticide which, when properly utilized, is effective against rats and mice. It is a dark gray powder that is relatively insoluble in water and alcohol. In the presence of moisture and/or dilute acids, it releases phosphine gas, which is very toxic and accounts for the garlic-like odor of the compound. It is stable for long periods of time under most conditions. It presents secondary poisoning hazards.

Because of its toxicity to all forms of animal life, the following methods and precautions should be adhered to in the use of zinc phosphide:

- This rodenticide is not recommended as a routine maintenance rodenticide, but rather as a short-term, single-dose, corrective agent.
- Zinc phosphide should not be used in a manner in which it is readily accessible to children, poultry, pets or domesticated animals. It may be necessary to utilize safety rodent bait stations to accomplish this in some situations.
- Zinc phosphide should never be utilized on a readily recognizable food material in a form attractive to humans.
- Zinc phosphide can be dusted onto wet baits such as meats or cubed fresh fruits and vegetables as long as they are made unrecognizable as food.
- When applied to dry baits such as grains, it is recommended that it be carried as a suspension in corn oil or warm bacon grease.
- When preparing zinc phosphide baits, operations should occur outdoors or in a room with positive ventilation. A respirator should be worn when mixing baits to prevent inhalation of the powder. If very large batches are being produced it is necessary to wear a gas mask approved for phosphine.

TRAPPING RODENTS

Types of Traps

Many types of traps are used for capturing commensal rodents. Included are common wooden-base snap traps, steel traps, wire live traps and multiple-catch box traps such as the Ketch-All.

Box or Cage Traps

Cage traps are designed to catch an animal and keep it unharmed until it can be removed for disposal. These traps may either catch one animal at a time or several. In the first case, a sliding door slams down behind an inquisitive rodent when his weight on the balanced floor or his greedy nibbling at a bait triggers the mechanism holding the door open. The multiple-catch trap is usually more intricate. For example, the Kness Ketch-All forcibly shoves a victim into a closed compartment and hurriedly opens its doors to the next prospective customer.

Glues

Sticky chemicals that entangle the victim may seem rather impractical for anything bigger than a fly, but they have been used in India for animals as large as tigers. Rodent glues are undoubtedly more effective for mice than aggressive Norway rats, but they are used for the latter, too. The sticky material is applied to heavy kraft paper, cardboard, roofing paper, etc., and placed in rodent runways. Glues can be purchased commercially.

Glues, however, have very definite limitations. They are messy and become less effective at low temperatures and under extremely dusty conditions. They are most often used in combination with other methods.

Jump or Snap Traps

This final category includes the traps that are the most useful in commensal rodent control. The steel jump trap, larger versions of which are used to catch many types of animals from muskrats to bear, usually catches an animal by a limb.

However, this type of trap is not necessary in control work and the PCO will find the wood-base guillotine or snap trap much more practical. The snap trap is cheap, easy to operate, somewhat more versatile to place, requires fewer inspections and, since the animal is killed almost instantly, more humane. For most purposes, this trap is the one recommended for use by the PCO.

Trapping Techniques

Effective trapping of commensal rodents depends on several factors. The most important is an understanding of rodents' basic traits. Norway rats, while as agile as tree squirrels when necessary, are more at home on the ground and will normally be caught there. Roof rats are fond of climbing and can be taken more frequently from their runs along pipes and supporting beams. The habits of mice vary somewhat from the other two types of rodents. They are much more inquisitive and explore their environment continually. It is this drive that causes a mouse to investigate a newly placed trap, whereas a rat is apt to avoid it because of the well-known "new object reaction." For this reason, rat traps should be permitted to remain in place longer than mouse traps.

Mechanical Condition of Traps

Before setting traps, make certain that they are in good mechanical condition. The time lost because an animal escapes is more expensive than the placement cost of a trap. If oiling is considered necessary, use oils of animal or vegetable origin rather than petroleum, which may have a repellent effect.

Rats and mice are thoroughly familiar with the odor of humans and their furnishings, and since the odor of rats that have been killed in a trap acts as an attractant, trap odors play only a minor role.

Discard older traps that have become rusty. The wooden base should not be warped, otherwise it will rock when the animal steps on it. Triggers should be adjusted so that a light touch will set them off, but no so fine that a passerby may jar them. Do not set the bait pan at an angle high enough for the animal to squeeze under it and jam it further back on the trigger, or so low that there is not place left to spring the catch.

Enlarged Bait Pans

While there is a commercial trap with an enlarged bait pan, most traps are not so equipped. Enlarging the bait pan with a small square of cardboard (not recommended for damp locations or prolonged use), thin metal or wire screen is a simple but very effective device. The enlarged bait pan turns the ordinary trap into a runway trap which, when properly set, will be sprung as the animal steps over it, even if he is not attracted by any bait.

Trap Shelters

A thin metal shelter constructed over the trap is another worthwhile modification. The main purpose of the shelter is to force the animal to pass over the bait pan, but it also acts as a drag to prevent loss of the trap and discourage piling of materials directly on it.

Trap Placement

Another important factor in determining success is the placement of the trap. For this reason, the value of "tracking patches" and reading signs cannot be overemphasized. Tracking patches are thin layers of flour, loose dirt, talc or other finely divided material that has little or no deterrent effect. The material is spread in one to two foot lengths in areas that animals are likely to frequent. These patches are smoothed over so that fresh tracks can be easily read, even by the untrained eye. This method enables the serviceman to determine what areas are being used by the animals, to estimate their numbers and, at the conclusion of a trapping period, to ascertain if any animals are still on the premises.

In addition to these artificial measures, a good trapper will look for signs left by the animals to show established routes. The body oils and extraneous filth picked up by rodents is laid down in a black line or smear since they normally press close to the wall of a familiar route. If roof rats are present, "swing marks" are made as the rats pass under rafters while travelling along a horizontal support. A keen eye can also detect the presence of fresh droppings, hair, and tracks in the dust. All of these signs can be used to determine the best placement of traps.

Place traps where active runs have been discovered. Set traps perpendicular to the run with the bait pan close to the wall or solid surface. If the traps are not enclosed in shelters as described above, it may be necessary to narrow the passageway with boxes or other solid items. This forces the animals to pass over the bait pans.

A common mistake of the novice is to skimp on the number of traps. For mice, with their limited movements in established habitats, one trap for every two to three square feet is not excessive. It is more efficient to overtrap an area than to undertrap.

However, even with good trapping techniques, some individuals will evade all efforts. It is the catching of these smart ones that taxes the ingenuity of the PCO. With roof rats, traps can be nailed on upright supports or fastened to horizontal pipes.

Traps can be camouflaged with torn strips of facial tissues, oatmeal, cornmeal or sawdust. If fine materials are used, it may be necessary to add miniature trap pads to keep the bait from collecting under the pan and to prevent the trap from springing. Also, putting two or more traps side by side, particularly in a shelter, will surprise even the most evasive rat.

A number of traps should be used. Traps should be placed within 10 feet of each other for controlling mice. Traps should be placed within 20 feet of each other for controlling rats. If rodents seem to be jumping over the traps they should be placed in groups of three or more in a parallel series. On horizontal pipes or beams, where traps are set in a series, one end should be tied to the pipe or beam. Then, when the trap is snapped, it will bounce off the support and hold the animal suspended in the air clearing the pathway for other victims.

Traps should be placed so they will not endanger pets or children. Ketch-All type traps, wire live traps, and snap traps designed only for mice are not considered dangerous, although they may bruise the fingers of a child. Larger snap traps and steel traps should not be placed in areas accessible to children unless they are placed in trap boxes.

Do not place any trap directly above food or food products or surfaces, equipment, or containers that exposed food will contact.

The number of traps placed on each job should be recorded. In food plants, the location of each trap should be mapped. This will enable someone else to follow up an account, if necessary.

Traps should be revisited frequently. Unless the trapped rodents are in concealed places, the traps should be checked as early as possible in the morning to remove the trapped animals. Trapped rodents are a discomforting sight to many people and the rodents can produce odors.

Dead rodents should be carefully removed because of the disease and ecto-parasite hazards. The carcass should be taken off the premises or put in wet garbage where it will soon be removed. Avoid direct contact with dead rodents by using gloves or long forceps.

Intensive trapping for several weeks is recommended. Traps should be left in place for at least five days before moving them to other locations, because there may be some "new object avoidance" when the traps are first encountered.

Baits and Baiting

When a trap with an enlarged pan is properly placed, it is not necessary to bait it. However, baiting increases the possibility of success. A light smear of peanut butter or a sprinkling of oats, cornmeal, doughnut or bread crumbs over the pan is suffient.

When an unmodified trap is used, baiting is essential. Many baits have been recommended, but there seems to be no universal bait that will appeal to all individuals in every environment. The following are a few that have been successful under some conditions: raisins, strawberry jam, ground beef, nutmeats, sardines, weiners, Grape-nuts, chocolate, apple, carrots, and sweet potatoes. Gumdrops make excellent mouse bait because they are difficult to remove without springing the trap.

Success is reported with bacon rind and cheese if they are attached to the bait pan and then toasted with a match. A semipermanent bait has been made by kneading bacon grease into small clay balls or chewing gum. If a highly attractive food source is already available, cotton for nesting has been very successful at times. The use of nesting material is also effective inside cold storage.

SELF-HELP QUESTIONS ON RODENT CONTROL

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. Describe the feeding habits of rats and mice regarding bait acceptance and condition:

2. When mixing rodent baits, where are the directions obtained from?

3. Placement of baits, prebaiting, and the amount of bait needed vary with the rodent. How do mice and rats differ in these factors?

4. List four anticoagulant rodenticides and explain their disruptive actions:

5. What safety factors may be employed to protect the public, children, and domestic animals when anticoagulant baits are used?

6. What precautions must be considered when using Antu baits?

7. Have rodent populations exhibited tolerance to arsenic trioxide and explain its usefulness in reducing rodent populations:

8. When using phosphorus paste, what safety factors must be considered to the applicator and the public?

9. Is red squill equally as effective in control of mice and rats? Explain factors:

10. What physical and chemical properties make sodium fluoroacetate a hazard as well as highly effective?

11. What steps must be followed by a P.C.O. in storage and use of the product "1080"?

12. Records of "1080" applications must be maintained for how long and consist of what information?

13. Why are rat populations hard to control with the use of strychnine?

14. When placing strychnine baits, what precautions must be considered:

15. What physical characteristics contribute to the long term and secondary poisoning hazards of zinc phosphide?

16. Why should zinc phosphide bait be prepared only with the best of ventilation or outdoors?

SPECIAL SITUATION PEST CONTROL

CONTROL IN FOOD ESTABLISHMENTS

Treatment of food handling establishments refers to treatment of the structure, its surroundings and equipment in it, in order to protect food from pets. Proper treatment of food handling establishments prevents food contamination by pests that wander into the structure or are carried in and which thereafter may find harborage in the structure of its equipment.

Use of Pesticides Supplements Sanitation

Safe and effective use of pesticides in food establishments requires that the establishments comply with all of those criteria of the appropriate current good industry practices which are concerned with sanitary operation and the absence of pest attractants, breeding places, and harborage of entry. Even with full compliance with these sanitary standards, there is frequent need to control pests. These include rats and mice, ants and cockroaches, as well as a variety of other invading and incidental vertebrate or invertebrate pests.

Records

Records of sanitation problems, pest problems and pesticide use in food establishments must be made and retained by the pest control operator. A copy of the record should be given to the person responsible for sanitation in the food establishment.

Pesticide records must include: (1) name of each product used: (2) concentration of pesticide in formulation applied; (3) type of application; (4) areas of application: (5) date applied; and (6) special records of use in high hazard rodenticides.

AREAS AND USE OF PESTICIDES

Outdoors

This is any area outside the structure and includes loading docks and refuse containers. Pesticides are applied to, or near, resting, harborage and breeding areas outside food establishments. Treatment prevents pests from

contacting food products in outdoor storage areas and from migrating to indoor areas. These treatments should be made in conjunction with an exclusion program using such barriers as self-closing doors, screens, air curtains, and rodent-proofing and the use of traps, especially light traps, against flying insects. Control of flies, rodents and birds starts on the outside and often can be obtained by outside application of pesticides.

Insecticides, if required, must be applied so they can neither contact food products stored outdoors, nor enter or be carried into the establishment. Special care is required in making application around windows, doorways, ventilators, and other openings leading to the inside.

Rodenticides are usually applied in attractive food baits or in water solution. Such baits ordinarily require containers that are adequate to protect animals and children as well as to avoid contamination of food. Special attention is required to provide sufficient space for effective placement of the containers and to protect them from damage and pilferage. Outdoor use of rodenticides is essential to intercept rodents before they gain entry into the establishment. Their use outdoors is considered in two categories:

1. Public: Areas that are not enclosed and the property is not isolated enough to prevent the public from having ready access to them.

2. Restricted (not accessible to the public): Areas which are enclosed by high fencing or other high barriers or properties so isolated that likelihood of the public or unauthorized persons having access to such areas is highly improbable. Some establishments may have most outdoor areas subject to the public but specific areas, such as power stations and refuse areas, may be restricted.

Nonfood Areas

Typical nonfood areas of food establishments include offices, locker rooms, toilets, machine rooms, boiler rooms, rubbish rooms, and garages. These are areas where food is not normally present, except perhaps as it is being transported from one food area to another, i.e., through a hallway.

Pesticides are used to control pests that may wander into or breed from migrating into food areas.

Insecticides can be applied in nonfood areas as space treatments, contact or residual sprays, dusts and baits. The person applying them must consider not only the premises to be treated, but also foot traffic or any items which, through transferral, could contribute to product contamination. Dusts may be used only under conditions that preclude their being tracked or airborne into food areas.

Rodenticides can be applied as liquids or as food baits and placed in concealed locations or in containers. Conditions of exposure fall into three categories:

1. Public: Such areas include dining rooms, eating booths, and aisles in supermarkets.
2. Employee (nonpublic, subject to employee traffic only): The public is restricted from such areas but authorized outsiders might occasionally be present. Such areas include garages, boiler rooms, offices, locker rooms, mop closets, toilets, and rubbish rooms.
3. Restricted: Such areas are normally inaccessible to personnel due to their physical location or construction. Included are crawl spaces and wall voids.

Food Storage Areas

Food storage areas vary from open floor storage to sealed tanks and are used for the storage of raw commodities, intermediates, finished products as well as containers and packaging materials. Food materials may be stored in bulk, in bags or in cases, boxes or cans.

Pesticides are applied in food storage areas to prevent pests from contaminating a raw product, the finished product or its container. Also, their use helps to avoid infestations which could spread to processing areas

Insecticides can be applied as space treatments, contact and residual sprays, baits and dusts. Consideration must be given to the type of packaging used to avoiding treatment that would cause food to be contaminated when emptied from the container or by migration through it.

Rodenticides are used in areas containing exposed food and nonexposed food.

1. Exposed food: any area in which food is uncovered or so packaged that it could be accidentally contaminated by rodenticides. Such areas include processing areas, kitchens, and serving areas. Storage areas are not considered as exposed food areas if foods are packaged in cans, jars, boxes, heavy paper bags, or other materials relatively impervious to rodenticides. Areas containing foods in burlap sacking and similar material should be considered "exposed food areas." A large warehouse might be considered to contain both exposed and nonexposed food areas, depending on the type of packaging in each area.

2. Nonexposed food: any area in which all foods are protected, as by packaging or otherwise, from accidental rodenticide contaminations. This would include a processing area consisting of a totally enclosed system so that the food, as it moved through the processing system, is never exposed to the immediate environment.

Food Processing Areas

Food processing areas vary from completely closed systems of conveyance and processing to those in which foods are completely exposed for varying periods of time. The latter are the areas of a food establishment requiring greatest care to avoid exposure of food to pesticides. It may be necessary, however, to apply chemicals in these areas to avoid pest contamination of the food product.

Insecticides can be applied as space treatments, contact or residual sprays, dusts and baits. Application of these pesticides to equipment may be done only in such a manner that, when cleaning follows, no pesticidal residue remains on surfaces which food will contact.

The use of insecticides and steps to protect food are described under the various sections below:

1. Food contact surfaces: Insecticides such as pyrethrins or allethrin (with or without synergists) or dichlorvos may be applied as contact sprays provided the particular formulation is registered for such use. Treated surfaces must be cleaned before operations are resumed.

2. Nonfood contact surfaces of equpment: Insecticides may be applied only in small amounts to cracks and crevices. Care must be taken not to contaminate food-contact surfaces.

3. Floors and lower walls: Selective treatments may be made using contact or residual insecticides applied into cracks and crevices. Applications should be restricted to cracks and crevices unless the infestation is unusual. If spot treatments are necessary, they should be restricted to areas below food-contact surfaces such as lower portion of walls and the undersides of shelving and the bases of equipment. Special care is required to avoid insecticide drift onto food-contact surfaces or into food itself.

4. Overhead areas: Great care is needed in treating upper walls and overhead objects to prevent contamination of food products or food-contact surfaces. Dusts cannot be used. Residual sprays should be used only when contact sprays are impractical. During any treatment of overhead areas, exposed food beneath the area to be treated must be removed or covered and all food-contact surfaces should be covered.

5. Space: Insecticides are applied as space treatments for control of exposed crawling insects and flying insects. Food must be removed or covered. Food-contact surfaces must be covered or cleaned after treatment.

Rodenticides are occasionally needed in food processing areas. As in food storage areas, the restrictions on the use of rodenticides are determined by whether or not food is exposed at the time and place the rodenticides are exposed.

METHODS OF INSECTICIDE APPLICATION

Space Treatment

Space treatment means the dispersal of insecticides into the air by foggers, misters, aerosol devices and vapor dispensers for the control of flying insects and exposed crawling insects. Food must be removed or covered during space treatments except as described below.

Contact (nonresidual) Treatment

Contact treatment means a wet spray applied to kill pests on contact. Only insecticides which dissipate quickly are used, and there is no significant kill of pests not contacted by the spray at the time of treatment.

Residual Treatment

Residual treatment is application of an insecticide so as to leave a deposit that will kill insects which may later crawl or rest on the treated surfaces. Such treatments are made to breeding places, harborages, and areas where pests are present and to surfaces where pests can be expected to hide, crawl or alight. Residual insecticides must not be applied to food or to food-contacting surfaces. Indoors, residual treatments are made with brushes or with sprayers operated at low pressures and in such a manner as to avoid spattering, "bounce off" or drifting spray mist. Clean paper or plastic sheets may be required to confine the treatment to the chosen target area.

General Treatment

General treatment means application to broad expanses of surfaces such as walls, floors, and ceilings or as an outside treatment to walls, lawns and shrubs.

Spot Treatment

This means restrictive application to selected surfaces where pests have been seen or are suspected or hiding or entering.

Crack and Crevice Treatment

This kind of treatment is the careful and precise application of small amounts of insecticides into cracks and crevices in which insects hide or through which they may enter the building. Such openings commonly occur at expansion joints, between different elements of construction, and between equipment and floors. These openings may lead to voids such as hollow walls, equipment legs and bases, conduits, motor housings, junction or switch boxes. The treatment should be carried out so as to cover thoroughly all cracks, crevices and other concealed pest entries or confined harborages and so as to minimize to the extent practical any contamination of exposed portions of floors or walls. It must not lead to contamination of food, containers or food-contacting surfaces.

Dusts

Dusts are finely divided solid particles of a toxicant, with or without an inert carrier. Insecticidal dusts are useful where sprays might be hazardous to the applicator or the equipment as in switch boxes and electrical motors or to reach recesses such as well voids which are not otherwise accessible to treatment. Dusts must not be placed where there is any likelihood of their being transferred to food, containers or food-contacting surfaces. Avoid the use of dusts where there is wind, sweeping, traffic or other activity that would cause them to be transferred or become airborne. Any dust left in the open after application must be removed.

Granules

These are coarse particles of an inert carrier impregnated or coated with a toxicant. Granules are used for application outdoors for insects living in or on the soil. They should not be distributed in areas where they are likely to be tracked indoors.

Baits

Baits may be used only in confined and enclosed spaces or at and below floor level only. They should not be used on floors which the food product or its containers can contact. They may also be applied to outside areas for control of crawling flying insects.

RODENTICIDE APPLICATION

Alternate Control Methods

As with all pesticides, rodenticides should be used to supplement practical programs of sanitation and exclusion. Trapping offers a safe, quick means of eliminating most stray and invading rodents but is not without certain disadvantages. Some rodents are trap-shy and cannot be caught. Some establishments are so designed that there are few, if any, locations where traps can be placed and where they will be effective while not hindering operations of the establishment. Trapping also has a high labor cost.

Role of Rodenticides

Rodenticides are essential tools in perimeter rodent control, which should be practiced around all food establishments. Rodents moving into an area travel along perimeters and will accept baits which might not be accepted once the rodents become established. Baits are most effective when used in perimeter control programs and such programs minimize the hazard of rodents entering the establishments and contaminating food. Indoor applications can eliminate those rodents which occasionally gain entry into an establishment. They are especially important in congested urban areas where perimeter control is not practical.

Rodenticides in Baits

Rodenticides are commonly exposed in food baits and, less frequently, in water, with or without dissolved attractants. Before any rodenticide is used, it is necessary to consider the nature of the infestation, the exposure of the food to adulteration by rodents or rodenticides, the characteristics of each

appropriate rodenticide and the results desired. The use of any rodenticide in a food establishment is acceptable only under conditions which preclude contamination of food. Also, its use must not endanger employees or other persons on the premises of the establishment.

Rodenticidal Dusts

Dusts such as Antu, and anticoagulants may be applied into burrows outdoors.

Burrow Fumigants

Fumigants including HCN from calcium cyanide, may be used outdoors to kill rodents in burrows. Care and good judgment is required in gassing burrows outdoors. This is especially true when the burrows are close to a building and there is a need to avoid any possibility that the gas might enter the building.

CONTROL IN HOSPITALS AND REST HOMES

Special considerations must be given in insect control in hospitals and rest homes because these two environments have limitations seldom encountered in other places where pest control is practiced. These limitations include: the presence of people who are ill or physically weakened; and people who are confined to areas (often a single room) 24 hours a day for varying periods of time which are sometimes measured in years.

Methods and Precautions

To the extent practical, insect infestations should be prevented, reduced, or eliminated through good housekeeping, sanitation, insect proofing, and nonchemical control techniques. When pesticides must be used in and around hospitals and rest homes, consideration should be given to:

1. potential hazard of the pesticide formulation and type of application to patients and applicators;
2. health status of the patients and the duration of their exposures;
3. persistence of the pesticide;

4. chemical and formulation of the lowest hazard level and the lowest concentration which will accomplish the desired control;
5. the insect species.

Before insecticides are applied in sensitive areas, a careful study of the infestation and its causes should be undertaken. So far as is practical, an engineering and sanitation approach should be pursued to reduce the possibility of reinfestation and to reduce the amount of pesticide which is required for control.

Insects should be stopped outside the building when practical. This can often be accomplished by:

- Establishing mechanical barriers such as screens and air curtains.
- Utilizing traps.
- Applying insecticides around the exterior perimeter of the building.
- Preventing entry with incoming goods. Food, clothing, and furniture which are brought in from outside are common sources of infestation and should be inspected. A course of action should be established for handling various incoming items found to be infested.

Infestation inside should be limited when practical to one area. Food carts and other vehicles with potential for distributing pests should be inspected routinely and treated when necessary.

Applications of insecticides should be made only to the harborages and to the surfaces frequented by the particular pests being controlled. Every effort should be made to minimize the treatment of exposed surfaces.

Attention must be given to various utility systems, particularly air conditioning, to avoid unintentional dispersal of pesticides during treatment.

When infestations are found in nurseries, examining rooms, surgical wards, or other areas where patients are placed, the following procedures should be followed:

1. Infested equipment should be removed if practical and treated and then thoroughly cleansed before replacing. (Equipment might also be fumigated or treated with cold or heat.)

2. If the room (or equipmet that cannot be moved) must be treated, patients should be removed. A nonresidual contact spray may be applied followed by adequate ventilation to remove insecticide and solvent vapors. NOTE: Special care must be used if pyrethrins are applied as some people, especially asthmatics, are allergic to them. In some cases, small amounts of residual material might be applied to cracks and crevices if the infestation is not likely to be corrected by applications of nonresidual insecticides.

3. If the room or equipment in it must be treated with patients present, only low-odor, nonvolatile chemicals and formulations may be used. Examples are Kepone, Baygon or Diperex baits, and Dipterex spray. Mineral oil may be used for trapping mites or small insects.

4. Infant bedding must never be treated with pesticides. Other mattresses may be treated, but should then be dried and covered with a plastic or rubber sheet before use.

5. Extreme care must be taken to avoid contamination of equipment that is sterile or will come in contact with a patient.

Vapona strips or automatic mist dispensers must not be used in patients' rooms. They may be used in storage or utility areas or in entry-ways.

CONTROL IN RESIDENCES

Before or during application of an insecticide, make a thorough inspection with a flashlight to locate infested sites. A flushing agent is often a useful supplement. All infested sites should be treated.

Where necessary, have dishes, pots, pans, and food removed or covered to protect them from possible contamination by insecticides (spray, drift or dust) during the treatment.

Preschool children, uncaged pets, and anyone suffering from respiratory ailments should not be permitted in a room during any application of insecticide in that room.

Protect caged pets and fish in tanks which remain in rooms being treated. Cover them and shut off air pumps for water tanks. During space applications and aeration thereafter, remove caged pets and tightly cover fish tanks with impervious material such as polyethylene. Make sure cages are free of cockroaches before moving them to another room.

Combination treatments utilizing residual liquids, dusts, baits, and/or space applications are more effective than using a single application technique.

Residual Liquid Applications

Should be made to cockroach harborages with emphasis on cracks and crevices and minimizing treatment of exposed surfaces. In many cases, however, to obtain good control, you must treat some exposed surfaces over which you expect cockroaches to crawl. Ordinarily, the application is made a low pressure wet spray.

Use care to prevent runoff and/or puddling. Heavy applications may stain or damage certain materials. Excess must be wiped up immediately.

Do not apply oil-base insecticides near open flames (pilot lights of stoves, ovens, gas refrigerators, etc.) or to floor tile.

Do not apply water-base insecticides directly into or onto electrical units.

Do not permit children or uncaged pets in the treated area until the treated surfaces are dry. Allow all treated surfaces to dry before dishes, pots, pans, foods, and other articles are placed on such surfaces.

Dusts

Dusts are useful for placing insecticides deep into cracks, crevices, wall voids, and other hidden harborages. Light applications are effective; heavy applications tend to be repellent. Dusts generally provide longer residual control than do residual liquid applications. Dusts become ineffective under conditions of excessive moisture. They are especially useful in electrical units. Do not foul electrical contacts with dusts.

When applying dusts, use gentle pressure to minimize dispensing dust particles into the room's atmosphere.

Baits

Baits are generally long-lasting and can often be applied to areas that can't be effectively treated with residual liquids or dusts. For maximum effectiveness, use small applications less than three feet apart rather than large applications further part. Baits are supplemental to dusts and liquid residual applications, except under unusual circumstances.

Baits should be applied so that they are inaccessible to children and pets.

Use caution when applying paste-type baits in heated areas, as heat often causes such formulations to run and drip.

Space Applications

This type of application will assist in flushing cockroaches from hiding places onto surfaces treated with residual materials. Space treatments alone do not penetrate cracks and crevices well enough to provide effective control and should be considered supplementary to residual dust and liquid applications except in unusual circumstances. Cockroaches on exposed surfaces can be killed with space treatments.

Advise the customer how long persons, pets, and fish tanks should stay out of the treated rooms or remain covered. Mechanical air pumps for fish tanks should remain off during the same period. This period of time is based upon the USDA registered label.

SELF-HELP QUESTIONS ON SPECIAL SITUATION PEST CONTROL

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. When servicing a food establishment, should a record of pest problems found, sanitation necessary, and pesticides applied be maintained; and who should be informed of these factors.

2. Can outdoor application of insecticides and rodenticides act as an effective barrier to avoid structure infestations? Explain:

3. Non-food areas can be treated with what types of sprays and with what general safety precautions?

4. When treating in food storage and processing areas, explain safety considerations needed before treating:
   a. around storage containers or open packaging

   b. around exposed food areas

   c. around nonexposed food areas

   d. food contact surfaces

   e. overhead areas

5. Define spot treatment:

6. Define crack and crevice treatment: Where is this effective?

7. Can dust applications be safely used around food contacting areas? Explain:

8. Explain perimeter rodent control:

9. What factors of pesticide to be used in nursing home treatment must be considered before treatment?

10. Discuss safety precautions to take if pest control must be done in surgical wards or nursery areas?

11. Should single application technique be employed for pest control in residences? Explain:

12. Residential applications pose safety and environmental problems. Discuss these when:

    a. residual liquid applications are made

    b. dust applications are made

    c. bait are used

    d. space applications are made

SAFETY

To insure safety in pesticide use, PCO's should:

1. Develop a written policy on proper grounding and use of electrical equipment.
2. Make sure your employees understand your company's policy on grounding and use of electrical equipment.
3. Provide and maintain proper electrical equipment and grounding devices including plastic-coated gloves.
4. Inspect and repair electrical equipment on a routine basis—weekly for periods of heavy use.
5. Inform your workmen not to use any piece of equipment they believe to be unsafe.
6. Provide on the device or its carrying case a checklist for safe operation of electrical equipment; for example:

   Before Operating This Tool:

   1. Check wiring
   2. Hook to adequate ground
   3. Put on plastic-coated gloves
   4. Avoid use in damp areas

7. Have qualified persons do electrical repairs.
8. Use cords and equipment approved by Underwriters Laboratories or Factory Mutual Engineering Corporation.
9. Check adequacy of electrical supply.
10. Provide proper cans for oily wastes.
11. Empty wastecans daily.
12. Store oil in closed containers.
13. Store flammable solvents in proper safety cans or acceptable containers.
14. Ventilate storage area.

15. Put out pilot lights and other flames before misting with oil.
16. Avoid using more than 1 gallon of fogging oil per 50,000 cubic feet.
17. Take special precautions to avoid spilling solvents and formulations with flammable solvents.
18. Clean up spilled solvents and formulation including those in vehicles.
19. Dispose of empty containers as soon as practical.
20. Post "No Smoking" signs in appropriate places.
21. Have proper guards on exhausts and mufflers on engines.
22. Avoid storage near heat or open flames.
23. Post warning signs near flammables.
24. Instruct personnel on hazards and how to avoid them.
25. Have dry chemical fire extinguishers on each vehicle.
    a. 2-1/2 pounds or larger per car
    b. 5 pounds or larger per truck
26. Have fire extinguishers
    a. on each fogging job where oil and insecticide is used, and
    b. where heating device is used
27. Have fire extinguishers in shop and office as required.
28. Have adequate fire lanes in shop.

The National Safety Council says that there are three ways to fight a fire:

1. Starve a fire by cutting off its fuel supply such as a pipe line, an electrical circuit or other source of fuel.
2. Cut off a fire's air supply. Smothering a fire is an effective way of cutting off oxygen and stopping the burning. The foams and dry chemicals are effective in this but there may even be occasions when literal smothering by a shovel of dirt, closing a door or putting on a cover may also achieve this end result.

3. Cool a fire. Here the object is to lower the temperature at the core of the fire. Water is of course the most effective coolant in most instances, but it is also important to know that on some fires water cannot be used.

For buring solids—wood, leather, paper, rubber, etc.—use water, either from a fire hose, a pressure water extinguisher or a soda-acid extinguisher. Aim the water at the base of the fire.

For fires in which the burning material is a flammable liquid, oil or grease, use one of the foam, carbon dioxide or dry chemical extinguishers. Don't get too close to the fire. Don't aim at the center of the blaze. This might spread it around. Work from the edges in getting as close to the fire as possible.

For fires in electrical equipment or involving electrical circuits, use one of the carbon dioxide or dry chemical extinguishers. Never, never use water or foam which has a water base. Aim the blast of gas right at the electrical fire. The object is to smother it with the gas or chemical.

HANDLING MATERIALS

Industry experience and the general requirements for safe and healthful working conditions do indicate that PCO's should provide lifting aids and safe equipment for transfer of materials from one container to another. There is also need to provide for effective control of chemicals and containers in vehicles.

In the shop:

1. To avoid lifting heavy objects, provide and use when needed:
   a. chain hoist
   b. combination rotary pump and syphon
   c. barrel pump
   d. universal barrel dolly
   e. dual purpose hand truck
   f. hand pump
   g. funnels.

2. Label all pesticide containers.
3. Provide proper light in work areas for safe operations including reading of labels.
4. Purchase concentrates in package sizes most suitable for safe and convenient handling.

In the Vehicle:

1. Use unbreakable or protected containers.
2. Label all pesticide containers.
3. Use storage racks or containers.
4. Secure kits, tools and containers against sudden stops.
5. Provide barrier between cargo space and seats.
6. Protect chemicals from overheating.
7. Provide for cleaning on a regular schedule.

SPILLS

PCO's should take all practical steps to avoid accidents, but should be prepared to handle accidentally spilled materials. Spills may occur in the shop, in vehicles or in public areas as in a wreck.

In the Shop:

1. Keep people away from spilled material.
2. Keep material from blowing or running away.
3. Provide clean up equipment including broom and shovel.
4. Provide absorbents for liquid such as that used in garages-vermiculite or sawdust.
5. Have container to hold spilled and contaminated material for proper disposal.

In the Vehicle:

1. Clean up promptly and thoroughly.
2. Soak up liquids -- use rat bait if necessary.

3. Have container to hold spilled and contaminated materials for proper disposal.

In Public (as at a traffic accident):

1. Keep people and traffic from contaminated area.
2. Keep spilled material from running or blowing away.
3. Notify police or other authorities.
4. Notify office.
5. Soak up liquids—use rat bait if necessary.
6. Shovel into containers.

PERSONAL PROTECTION

Among the steps which pest control operators can take to provide effective equipment to guard against undesirable exposures to chemicals and to guard against physical injury include the following:

1. When using and handling chemicals, contact should be avoided as far as possible.
2. Equipment must be provided to prevent harmful contact with injurious chemicals.
3. Equipment must be appropriate for its use and for the chemical being handled.
4. Employees must use equipment as directed. Employees must protect equipment against damage.
5. Employees must inspect equipment and report any damage for failure.
6. Employees, depending upon their work, should use appropriate equipment such as:
   a. gloves
   b. dust masks
   c. respirators
   d. detection equipment for fumigants
   e. extra set of clean clothing
   f. safety glasses or face shields for drilling or chiseling

g. soap and water

h. hard hats

i. shoes with special soles for bird and roof work

j. knee pads

k. protective boots—for soil treating

l. protective clothing—for soil treating and crawl space work.

PCO's Should:

1. Have positive ventilation in storage areas.
2. Be sure air from pesticide storage area is drawn away from adjacent storage or living areas.
3. Ventilate treated areas as described on pesticide labeling.
4. Mix zinc phosphide baits out of doors or under hood.
5. Store fumigants in separate building.
6. Keep containers of pesticides tightly closed.
7. Be sure furnaces, water heaters, and waste plumbing system are properly vented.
8. Empty and purge A-dust gun before bringing into vehicle or shop. Have a written policy on this matter and attach a reminder label to each A-dust gun.
9. Ventilate pesticide storage compartment of vehicles.
10. Don't operate vehicles indoors unless exhaust is connected to outside discharge.
11. Don't test fog mist machines inside—DO IT OUTSIDE.
12. Keep supplies near loading area to minimize ventilation problems.
13. Clean vehicle interiors on a regular schedule and whenever spillage occurs.
14. Have a shower, fingernail file and hand brush available at the shop.
15. Have water, soap and disposable towels in vehicles.
16. Have clean clothes for changing in emergencies.

TYPES OF RESPIRATORY DEVICES

Two kinds of respiratory protective devices are in general use—chemical cartridge respirators (hereinafter referred to as respirators) and gas masks. Most respirators are designed as half-face masks that cover the nose and mouth but do not protect the eyes. They have one or two cartridges attached to the facepiece by a clamp or secured by a holder. The respirator facepieces are equipped with one-way valves, which allow the inhaled air to pass through the cartridges but prevent the exhaled moist breath from passing through the cartridges. Gas masks usually cover the entire face. Their facepieces are made to hold a canister directly or to connect to the canister with a flexible hose. The hose-type canister is carried on the chest or back by means of straps.

Respirator cartridges usually contain an absorbing material such as activated charcoal. All the respirators listed in this report also have very efficient filters, which remove dust and spray particles and thus prolong the life of the absorbing material. Gas-mask canisters always contain more absorbing material and longer life filters than respirator cartridges.

Federal requirements stipulate a gas-mask canister life of one-half hour when the device is worn by men performing moderate exercise in gas concentrations up to 2 percent. The life of the canister will vary according to the concentrations encountered, e.g., one hour for 1 percent. The life of chemical absorbing cartridges or canisters will also be affected by humidity, temperature, and volume of breathing. High humidity shortens the life of cartridges and canisters in use and in storage. Mist, sprays or water, and rain reduce the effective period of the units.

Because of the difference in their protective capacity, gas masks, not respirators, must be worn when pesticides are formulated or mixed in close or inadequately ventilated spaces or when operators are exposed directly to concentrated dusts, sprays, or aerosols, as in greenhouses, indoors.

Use and Care of Respirators

Instructions given on pesticide labels concerning respiratory protection should be carefully observed. The use of respirators is not a substitute for essential precautions. Protective equipment herein discussed is indicated for use when mixing or handling all pesticides in poorly ventilated areas, at high temperatures, or in the field.

It is necessary that respirators be used in handling pesticides during the loading of distribution equipment, when containers are being disposed of, and whenever operators are exposed to obvious amounts of dusts or mists of the more dangerous pesticides. Field operators who may be exposed continuously during the day or for successive days to small amounts of toxic pesticides—even those not readily detectable—should faithfully use respirators as a precaution.

When respirators are used, the following practices are necessary:

1. Change filters twice a day or oftener if breathing becomes difficult.
2. Change cartridges after 8 hours of actual use or oftener if any odor of the pesticide is detected.
3. Remove filters and cartridges and wash the facepiece with soap and warm water after use. After washing, rinse it thoroughly to remove all traces of soap. Dry the facepiece with a clean cloth that is not contaminated with the pesticide. Place the facepiece in a well-ventilated area to dry.
4. Store the respirator, filters, and cartridges in a clean, dry place—preferably in a tightly closed paper or plastic bag.

The respirator should be fitted properly on the face, not too high on the nose, with the narrow part over the bridge of the nose, and the chin cup contacting the underside of the chin. Headbands should be adjusted just tightly enough to insure a good seal. Manufacturers can supply special facepieces if the standard one does not fit.

Conditions Requiring Gas Masks

Respirators do not provide needed protection from inhalation of pesticide dusts, mists, and vapors for operators formulating or mixing pesticides in closed or inadequately ventilated spaces. Full-face gas masks equipped with tested canisters are worn under these conditions. In addition, proper protective clothing as specified on the pesticide container label should be worn when applying certain pesticides in greenhouses or other enclosed spaces.

Other Essential Precautions

The use of respiratory protective devices does not eliminate the need for other precautions in handling toxic pesticides.

Provide for adequate ventilation of the area where pesticides are loaded or mixed. Always wear well-made natural-rubber latex gloves when handling concentrated materials. Check the condition of the gloves frequently and discard them if they develop pinholes or breaks. If any of the organic phosphorus insecticides are spilled on the skin or clothing, wash immediately with laundry soap. Never wear clothes that have been contaminated with pesticides until they have been washed. If at any time the concentrated pesticide is spilled, cover it immediately with dirt, clay, or sand. Then cover the contaminated area with washing soda or lime.

If an operator shows any sign of dizziness or nausea, he should immediately be removed from the area and placed in the care of a physician before he returns to work.

Before a facepiece, cartridge, or canister is purchased, make sure it is approved for the job you want it to do. A responsible supplier is one of the best sources of this information.

SELF-HELP QUESTIONS ON SAFETY

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. What should the PCO do to insure the safe operation of electrical equipment?

2. List three things the PCO should do for handling oily wastes:

3. How should flamable solvents be stored?

4. List three locations where fire extinguishers should be available:

5. What are the three ways to light a fire as described by the National Safety Council?

6. Name three lifting aids for use in the shop to avoid lifting heavy objects.

7. Should pesticide containers used in the shop be labeled?

8. List four of the seven suggestions for handling pesticides safely in vehicles:

9. What precautions should be taken for handling pesticide spills in the shop?

10. What precautions should be taken for handling pesticide spills in vehicles?

11. What should you do if pesticides are spilled as the result of a wreck?

12. What steps should the PCO take to guard against undesirable exposure to chemicals?

13. List six considerations that should be given for pesticide storage areas:

14. What are the two types of respiratory devices?

15. The use and care of respirators is not a substitute for essential precautions. When respirators are used, what practices are necessary to insure safe use?

16. What conditions require the use of gas masks?

17. List other precautions besides respiratory protective devices for handling toxic pesticides:

LABELING SERVICE CONTAINERS

"Service container" is defined as anything used to hold a pesticide intended for use by a PCO other than (1) the original labeled container as supplied by the manufacturer, or (2) an application device. Such a container of pesticides is not to be used by or sold to the public or to be used for interstate shipments by commercial carriers.

Seven items of information are required for adequate labeling of service containers.

1. Identification of the contents as materials used in pest control or exterminating: The words "EXTERMINATING CHEMICAL" are recommended. These words are considered to be meaningful to more people than the words "pest control chemical." The later term will be considered acceptable in areas where substantially all of the population reads English and where the industry is commonly known as pest control rather than exterminating. Where there are people who do not read English, "Exterminating Chemical" is the preferred identification. It is particularly useful to persons reading French or Spanish as there are words in those languages with the same meaning and almost identical spelling.

2. A warning as to the degree of hazard associated with the product: Nearly all products which pest control operators carry require a "warning" label. Only a few products warrant labeling as "poison." For such products, the skull and crossbones as well as the word "DANGER" are added. This "POISON" label will appear on the original container and the same "POISON DANGER" warning should be carried if subdivided into service containers undiluted. Three common pesticide chemicals would carry this same "POISON" warning if diluted, as follows: DDVP, sodium fluoroacetate, and strychnine. All others commonly used require "WARNING" label.

3. The name(s) and concentrations(s) of the active pesticidal ingredients: These two items should be inserted in the appropriate form label. The names should be as informative as possible to PCO's, the public and physicians. Use the well-known common name such as arsenic, Baygon, chlorobenzilate, Warfarin or zinc phosphide. Avoid names that are overly

technical or those that would be meaningless in case of emergency such as "Super-Spray."

4. General Precautions: For both the "Warning" and the "poison" label, the precautions are the same: "Do not swallow or spill on skin" and "Keep away from children." These statements are reminders to the PCO who uses the container daily, but they also provide concise precautions for someone who might be unfamiliar with the pesticide.

5. What to do in Case of Accident: For both types of labels there is instruction to call a doctor or a hospital.

   For poisons there is an added first aid instruction: "cause vomiting—wash from skin." The materials requiring the poison label are so potent that promptness in removing them from the victim is considered essential by our consultants. The instruction concerning vomiting applies to all of these highly toxic formulations including oil solutions.

6. That the Product is the PCO Use Only: Service container labels are not adequate for products that are to be sold. This fact is emphasized by the recommended working "Not to be Sold or Given Away."

7. The Name, Address and Phone Number of the Pest Control Firm: It will be necessary to insert the firm's name, address and telephone number in the spaces provided on the form label. They are required so that the ownership of the container can be determined. Medical personnel may require detailed information which the owner-firm should have on the label of the original container or in technical literature.

SELF-HELP QUESTIONS ON LABELING SERVICE CONTAINERS

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. Is an application device considered to be a service container?

2. Do service containers need a warning statement?

3. Should the service container label bear the name of the active ingredients only or should the label include the concentrations of the pesticides?

4. Is it necessary to insert the firms name, address, and telephone number on the service container label?

DISPOSAL OF PESTICIDES

HANDLING AND DISPOSING OF CONCENTRATES

Usable concentrates for which you no longer have a need should be kept in the original container. Return them to the supplier if possible or offer them to a fellow PCO. If neither wants them, store them until a proper disposal method is developed.

Unusable concentrates are those which have deteriorated, are contaminated by another material, or cannot be accurately identified, perhaps because they have lost their label. Some suppliers might accept these concentrates, but be sure to tell the supplier why you think the concentrate is unusable. If the supplier is unable to accept such concentrates, store them until a disposal method is developed.

All concentrates should be stored in the original container if possible. The storage area should be dry to minimize rusting of metal containers or damage to paper containers. You should mark the date of receipt of each concentrate on the container. Its age may be important for future disposal.

If the original container develops a leak, transfer the concentrate to another labeled container. Under special circumstances you may be able to get a replacement label from the original supplier.

Don't ever mix and store two or more different concentrates for disposal. Disposal techniques may differ for different pesticides. Don't burn concentrates unless the registered label provides instructions for such; toxic smoke or gasses may be emitted and the ash may be toxic.

HANDLING DILUTED MATERIALS TO MINIMIZE EXCESSES

Planning ahead is most important when using diluted materials that break down quickly. You'll have nothing to dispose of if you mix up only what you need that day. Keep stable diluted materials until you can use them again.

Using it up according to the directions on the label is the best way of handling any extra pesticide. Give the customer a little extra by treating an extra room or another foot of outside perimeter with those last few ounces of insecticides if it's the end of the day. If you can't use it on the customer's property, use it at the shop or at home that night according to the label.

Stability of diluted materials. There are no significant stability problems related to diluted insecticidal dusts or diluted oil base sprays, if the label directions are followed. Oils must be free of water, however, or insecticidal breakdown may occur. Water-base sprays held overnight should be well mixed the next day to be sure they haven't settled out. You may wish to store sprays in a separate container overnight to avoid possible damage or corrosion to hoses, gaskets, and spray tanks. Be sure such "holding" tanks are properly identified with a label.

Water rinses also should be sprayed out according to the label. An alternate is pouring them into termiticide tanks to be applied into the soil with termiticides.

Disposing of Containers

All containers that cannot be returned or sold should be handled as follows:

1. Rinse and dispose of the rinse as described above.
2. Render nonusable by breaking, smashing and/or puncturing.
3. Wrap all small containers (five gallon size or smaller) in newspaper or similar material. Before wrapping aerosols, puncture as described below.
4. Take to municipal or authorized private sanitary land fill or have them picked up by local trash collection agency.

Containers should not be burned unless the registered label provides such directions. Burning in most incinerators does not completely break down all pesticides. Toxic gasses, vapors, or particles are released into the atmosphere. The distribution of these "by-products" cannot be controlled.

Containers should not be buried on your own property. Burying containers on your own property will result in accumulations of concentrated pesticides in one area. Such accumulations are not easily broken down by natural forces and they present a potential hazard during floods and other natural catastrophies. Burying on your own property should be done only if there's no other disposal method available and if your property is large enough to permit burying containers in many areas rather than in a concentrated area.

Disposing of Contaminated Wiping Rags, Absorbents, Etc.

All wiping rags, cardboard trunk liners, old gloves and similar materials contaminated with pesticides should be disposed of through community trash services. First cut or shred them so that no one else will use them.

Expose absorbent materials such as vermiculite, sawdust, or sand to the sun if contaminated with organic phosphates or carbamates to deactivate the pesticide. After exposure for two or more weeks, you may dispose of them through community trash collection services. Materials contaminated with chlorinated hydrocarbons should be used as treated backfill in termite control. If this cannot be done, place small amounts in containers that are to be disposed. You might also save and reuse absorbent material after drying it but be sure to label it so that you know it's been contaminated.

Aerosol Containers Need Special Handling

Aerosol cans require special handling because they may explode if heated and those which do not discharge because they have stuck valves or other flaws create a dual hazard. Usually, the insecticide in such cans is in a concentrated solution in a flammable solvent which can be sprayed with explosive force if the container is punctured or is overheated.

Never leave aerosol containers on the customer's property. Return them to the shop for safe handling.

Emptied containers for ordinary pyrethrin-type and other household-use aerosols can be discarded for pick up by ordinary trash collection agencies. Before discarding them, shake to be sure they are empty and if necessary, empty as instructed on the label.

SELF-HELP QUESTIONS ON DISPOSAL OF PESTICIDES

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. What is meant by the following terms and how can they be disposed of properly?

   a. usable concentrates

   b. unusable concentrates

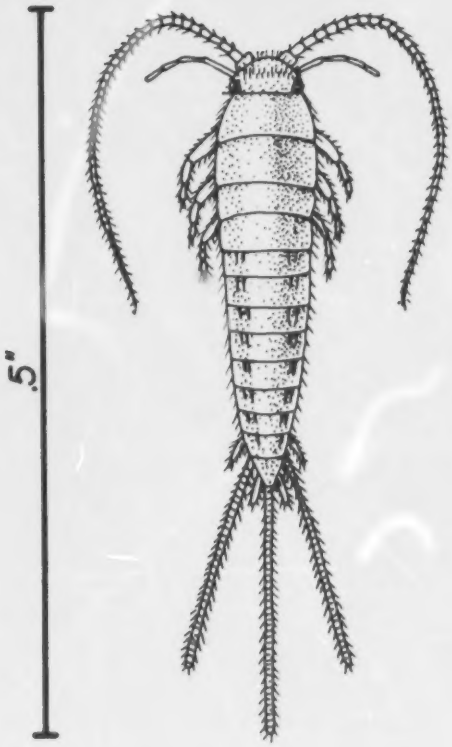
2. Proper planning, use directed by the label, and product stability help to assist in proper pesticide disposal. How may they be considered and used to minimize excesses?

3. List four procedures which may be used to detoxicify and dispose of used containers:

4. Will the pesticide label instruct the applicator on container disposal?

5. Aerosol container disposal is hazardous. Explain:

INSECT PESTS IN BUILDINGS



Silverfish and firebrats are wingless insects, generally gray in color and about one-half inch long. The young closely resemble the adults and both rapidly on floors and walls and ceilings. They are torpedo-shaped; that is, rounded in front and tapered toward the rear. They have long delicate antennae and three bristles arising from the rear end of the body; hence the common name bristletail. The name silverfish, which is applied to three of the four common species, is appropriate, as not only are they roughly fish-shaped, but they are covered with delicate scales which give them their color.

This may be a solid silvery gray or mottled tannish-gray. The fourth species, the firebrat, has mottled tan gray scales which may rub off to show the yellow body wall.

Silverfish and firebrats being small, thin and very flexible, are particularly well-adapted to hiding in cracks, as behind baseboards, behind door and window frames, under wallpaper and between layers of some kinds of pipe insulation. From such hiding places they move out in search of food.

In homes they are often found in basements, closets and bathrooms. Their appearance in bowls and tubs does not mean that they come up drains but rather that they have fallen in and cannot climb the slippery walls. They commonly occur in new buildings where the supply of fresh food in wallpaper paste, sizings and some types of pipe insulation plus the moisture in a new building creates ideal breeding conditions. In making an inspection for silverfish or firebrats, be sure to check all parts of a building from the basement to attic. A few of these insects seen on one floor may mean that there is a heavy infestation a floor or two above or below.

The Common Silverfish

Description: The silverfish is the most slender and delicate of the four common species. The adult is one-half inch in length (not including appendages) and dark steel gray to almost black in color with a metallic sheen. It is found throughout southern Canada and the United States, but is most common in the eastern United States.

Habits and habitat: The silverfish is sensitive to moisture, especially moisture in air. A relative humidity of 75-97 percent seems to be preferred. Because of its high moisture requirements, the silverfish is usually found at the lower levels of buildings such as the ground floor, basements, foundations or near water and drain pipes. It is common in new buildings where green lumber and plaster provide moist conditions. It will make excursions into dry areas for food. Its movements are restricted in heated buildings during the winter because the heat drives out many of the suitable habitats.

The silverfish prefers a temperature between 70°F. and 80°F. The adults die at or above 98°F. and eggs fail to hatch above 90°F. 72°F seems most favorable for reproduction and longevity of the adult.

Feeding: Silverfish and firebrats usually feed on objects which have been glued, starched, sized or pasted. Bookbindings, starched cloth, labels on cans, wallpaper and glossy papers are examples of materials often damaged. The feeding is usually on the surface of the object damaged and may result in the removal of writing or printing from papers but without a hole being made. Some synthetic fabrics like rayon may be eaten, especially when sized or starched. Feeding damage to curtains where they contact window sills is good evidence of silverfish or firebrat infestation. They can go for long periods (up to a year) without food, so sanitation alone will not eliminate an infestation although it may prevent a new one from starting.

The Firebrat

The firebrat is similar to the silverfish in size. The young are colored the same, but the adult firebrat has a distinctly mottled gray appearance.

The firebrat has the same goegraphical distribution as the silverfish. Unlike the silverfish, the firebrat prefers temperatures above 90°F. The optimum temperature appears to be between 98°F. and 102°F. The nymphs and adults can survive temperatures from 32°F. to 112°F., but the eggs fail to hatch at temperatures below 75°F. A relative humidity of 70 percent to 80 percent is favorable for this species. Firebrats are rarely found outdoors. Indoors they are usually found near heating units, fireplaces and heat pipes.

The Four-Lined Silverfish

Description: The four-lined silverfish is larger than the preceding two species, the adult reaching a length of three-fourths of an inch. The adult is somewhat darker than the firebrat, being tannish gray in color with four dark lines running down the length of the back. It is also flatter than the firebrat. The young are light brown, often tinged with pink until the fourth molt which occurs a month or so after hatching.

The four-lined silverfish is common in eastern United States and the south and central parts of Canada. It occurs as far south as Georgia and Arkansas and west to Missouri and Iowa. It is also found in California.

Habits and habitat: The four-lined silverfish prefers temperatures between 80°F. and 85°F., but can do well at higher or lower temperatures. It does not have strict moisture requirements.

This species is found throughout houses, from basement to attic. It forages for food inside and outside and is often found in the mulch in flower beds around foundations. It occurs in unattached garages and can probably survive mild climates without man or his dwellings. The largest populations seem to occur in attics, particularly in houses with roofs or wooden shingles. Treatment consists of application of chemicals in all infested areas, paying particular attention to attics, foundations and plant mulch. Unattached garages and other associated buildings should be examined and treated if infested.

The Gray Silverfish

The gray silverfish is very similar in size and habits to the four-lined silverfish. The adults and older nymphs differ in that the gray silverfish is uniformly light to dark gray. Eggs are laid in batches of 2 to 20 in crevices during the warm months.

The gray silverfish has been reported from North Carolina, Illinois, Missouri, Louisiana, California and Hawaii. The habits are similar to those of the four-lined silverfish except that the gray silverfish does not drink water. It is found throughout the house, but has never been reported on the outside walls.

COCKROACHES

The general shape of cockroaches is familiar to nearly everyone. With their flat bodies and long spiny legs, they are well equipped to run rapidly over a variety of surfaces and to squeeze into cracks and other hiding places. The young (nymphs) resemble the adults except that they have no wings. The adults of some species are fully winged while in others the wings may be short, especially on the females. The males are generally not so broad as the females, which are often seen carrying their purse-shaped egg cases. Roaches are seldom active in the daylight and when disturbed quickly scurry away to a hiding place.

Where only a few roaches are present, it may be very difficult to see live ones but there are several signs of their presence that may be found. All roaches

leave an odor on objects they rest on for any length of time. This characteristic must smell may give you a good hint to their whereabouts. It is different from, and not so strong as, the smell left by bedbugs, which are sometimes confused with young cockroaches.

Occasionally you may find the cast skins which the young roaches shed as they develop. You may find full or empty egg capsules. The little purselike cases are ridged crosswise and are brown to black in color. Another sign of the presence of roaches is the stains they leave with their excrement. Since the latter is often liquid, the stain may resemble that left by a drop of dirty. greasy water. If dry, they may look like large grains of soil. Droppings from roaches generally bear six lengthwise ridges which will distinguish them from small mouse pellets.

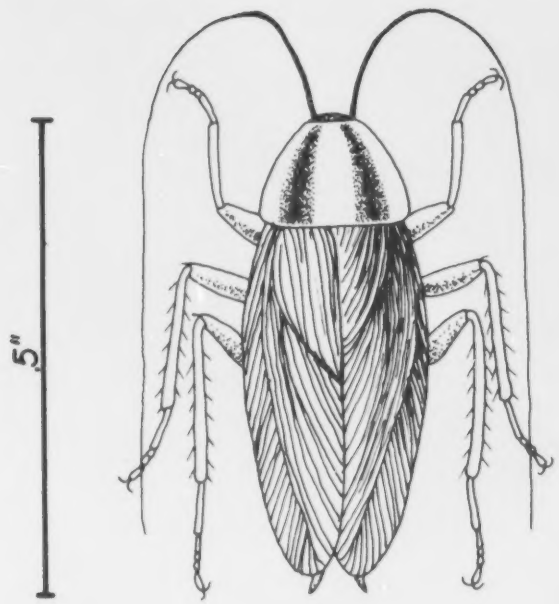
Cockroaches spread filth, contaminating far more than they eat. They thrive in both sanitary and unsanitary places. They are easily spread from building to building. No matter how heavy the infestation, the general public tends to avoid business places which have exhibited evidence of an infestation, thereby causing great economic loss to the operators of restaurants and stores.

Roaches have not yet been found to be direct carriers of disease; but indirectly, by contaminating food or utensils, they may aid in the spread of organisms causing food poisoning, dysentery or diarrhea.

All cockroaches have three life stages: egg, nymph and adult. Eggs are deposited in groups in an egg case or capsule (ootheca). With the exception of the German roach, most female cockroaches drop or glue their egg capsule to a surface as soon as it is formed. The German roach carries the capsule protruding from the top of the abdomen until the eggs are ready to hatch.

The young roaches (called nymphs) are wingless. They shed their skins (or molt) several times, the number of molts depending upon the species and the conditions under which the roaches are living. At the last molt, the wings are fully developed and the roaches are now adults.

The German Cockroach



Description: The German cockroach is light tan to medium brown in color. The adult is one-half to five-eighths inch long and has wings covering the rear end of the body. The shield immediately behind the head is marked by two dark stripes which run lengthwise on the body. Young German roaches resemble the adults except that they are wingless and darker in color, often being nearly black. A single light stripe running down the middle of the back is the most prominent marking on the young German cockroach.

Habits and habitat: The German cockroach is found throughout the United States in all types of buildings. Unlike most other roaches, the female German roach carries the egg capsule protruding from her abdomen until the eggs are ready to hatch. The capsule is then dropped and the young emerge within 24 hours. The female may drop the capsule earlier under some conditions. This usually occurs when the female comes in contact with an insecticide. Fewer eggs hatch from capsules dropped several days prematurely, while none will hatch from capsules dropped four or more days prematurely. The female may mate more than once.

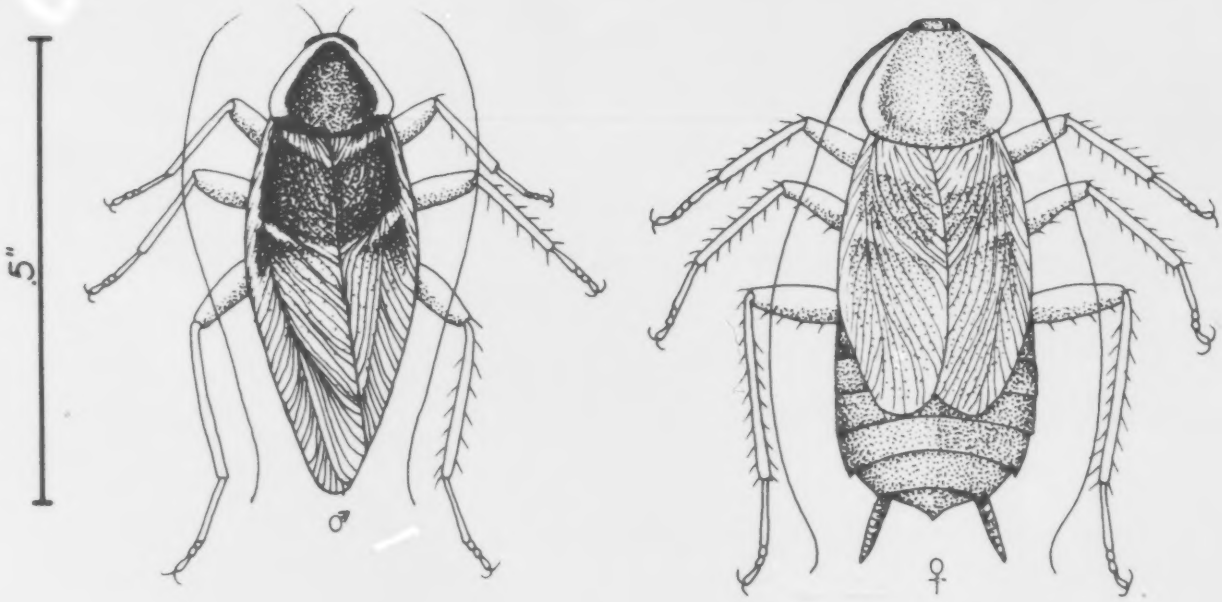
The nymphs have habits similar to those of the adults. They dislike light and hide in dark crevices during the day and are active at night. If German roaches are seen in clusters during the day, the population is so large that the available cracks are already full.

They usually hide in areas close to moisture and food which means kitchens and other food areas. They appear to prefer to rest on wood rather than on metal or other smooth surfaces. Large infestations do occur on metal surfaces when there are few other surfaces available such as in a submarine or a large, modern food processing plant with stainless steel equipment.

Infestations are sometimes found in areas not generally suspected of German roaches, for example, dresser drawers in bedrooms. When German roaches are found scattered through nonfood areas of a building, it is usually caused by a very heavy infestation. Roaches in these areas will find food scarce, but could feed on scattered crumbs, soiled clothing and the glue on dresser drawers. German roaches are also found outdoors during warm months and this, too, is usually due to heavy infestations. In such cases, they are usually associated with garbage receptacles.

Feeding: The German roach is a general feeder, but it seems to prefer fermented foods. Malt syrup seems to be very attractive to these roaches. If the adults have water, they can live about a month without food, but young nymphs die of starvation within ten days. Without food or water, the adults die in less than two weeks.

Although the adult German roach has well-developed wings, it rarely flies. It easily gains entrance into buildings because of its habit of hiding in cartons, bags, etc., which are transported from place to place.



Brown-Banded Cockroaches

Description: Brown-banded cockroaches are light tan to glossy dark brown in color and when fully grown may be five-eighths inch long. The young and females are broad in outline when seen from above. The adult male is rather slender and has wings covering the abdomen, but the female's wings are short. The name "brown-banded" is derived from the fact that they have two bands of lighter color (light yellow or cream) across their backs. These bands may be somewhat irregular or broken and are more apparent on the young and the females than on the males. At any rate, the markings on the back of brown-banded cockroaches are roughly crosswise, while those on German cockroaches are lengthwise. The purse-shaped egg capsules are light brown in color and are cemented in place, usually to the side or under surfaces of infested objects.

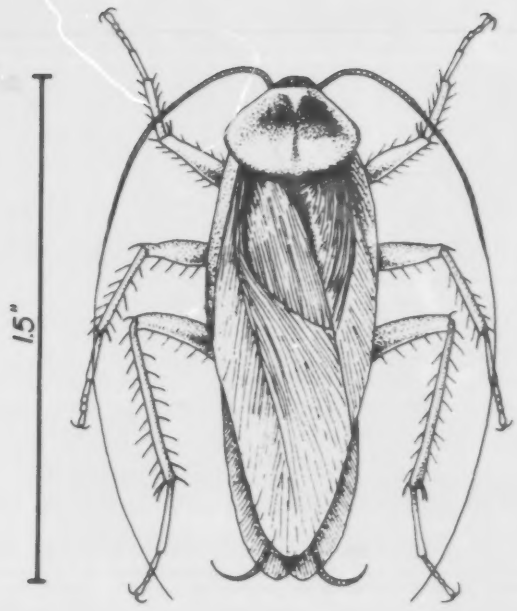
Habits and habitat: The nymphs and adults have similar habits and prefer temperatures of 80°F. or higher. They do not require as much moisture as the German cockroach does, which helps explain why they are normally found in rooms other than the kitchen or bathroom. These roaches dislike light and are not normally seen during the day.

When making an inspection for brown-banded cockroaches, look beneath tables and chairs, dressers and chests, also behind pictures, along picture molding, on rough plaster walls and ceilings, and most especially on the ceilings and upper walls of cabinets, pantries and closets. It may require some persuasion before you are permitted to inspect the furniture and closets of dining room, living room and den; however, brown-banded roaches may be found in some of these rooms and not in the kitchen. No room is immune; nor is any piece of furniture, wood, metal or upholstered, if its construction provides shelter. You may find tiny black droppings or cast-off skins where they have fallen from above onto shelves or ledges.

These roaches are more often found in homes, apartments, hotel and hospital rooms than in stores, restaurants and kitchens. They are frequently transported in furniture and will rapidly spread throughought an entire building. They have long been abundant in the southern states, but they have made such numerous appearances in the Midwest, Northeast and other temperate areas, thriving in heated buildings despite the more severe winters, that they may no longer be merely a sectional problem.

Feeding: The brown-banded roach's favorite feed seems to be starch materials because of the areas where they are found. They will also chew on nonfood materials such as nylon stockings. Their water requirement is lower than that of of other roaches. The adults are fair fliers.

American Cockroach



Description: The American cockroach is the largest roach commonly found in buildings in the United States. It is reddish brown in color, except for a tan or light yellow band around the shield behind the head. The adults are about one and one-half inches long and have wings. The young nymphs are wingless but they, as well as the adults. run very fast. Egg capsules of American roaches are about one-third inch long, mahogany brown in color.

Habits and habitat: In the north the adults live indoors, while in the south they live outdoors.

The capsule is usually dropped near a food source or along the walls of basements and where the female will attempt to cover it with debris if such is available. Occasionally, the capsule is attached to a wall or other surface.

In the south the capsules are commonly found outdoors embedded in decaying, moist wood, cracks in bark and in whorls of palm trees.

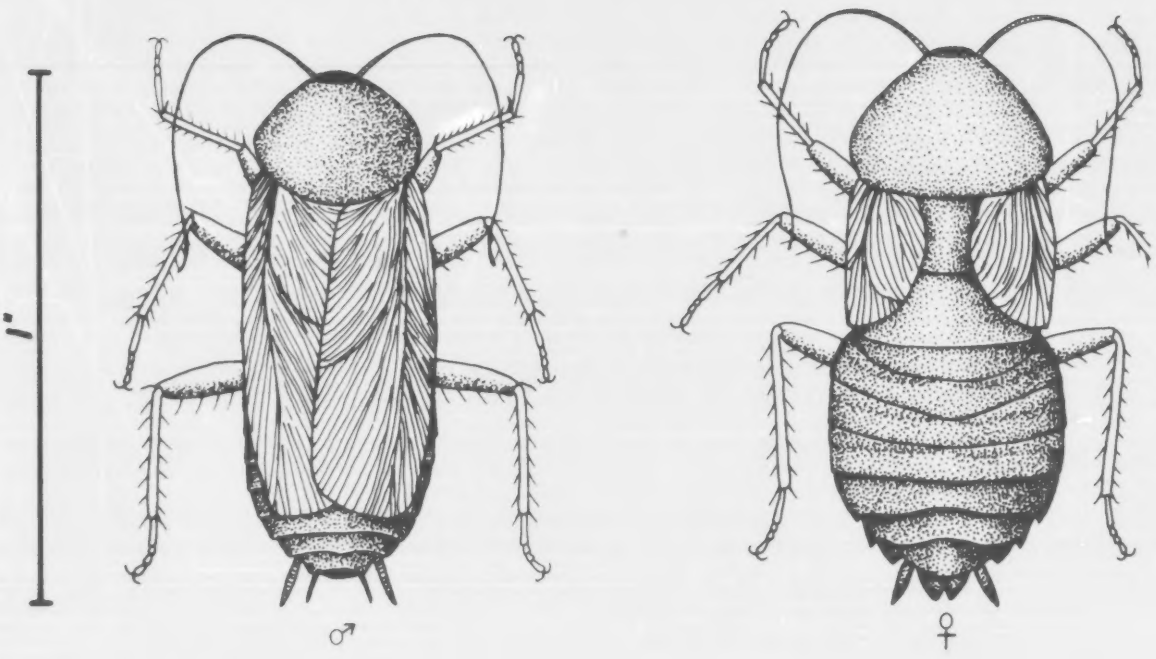
The nymphs and adults are found in dark, moist areas such as around bathtubs, clothes hampers and in sewers. They are common in basements and are usually found high on the basement walls and in the corners. In the north, this roach is commonly associated with steam heat tunnels. As this structure decreases in cities, the American roach in the north will be primarily restricted to large institutions and industries which still use steam heat tunnels. The American roach is also common around manholes in sewers and on the underside of metal covers of large sump pumps in boiler rooms. This roach has been found on flat roof tops in the Midwest where rain water has accumulated.

In the south, this roach is abundant in alleyways, yards, hollow trees and palm trees. When palm trees are sprayed for other insects, the roaches leave the trees and enter homes. They have also been observed migrating from one building to another in the north during warm months.

The adults have well-developed wings, but seldom fly. They are capable of gliding long distances and will cover considerable distances if they take off from a tree or roof top. Any large *Periplaneta* species seen flying rather than gliding is probably not *P. americana*.

Feeding: These roaches feed on a variety of foods, but decaying organic matter seems to be preferred. They also feed upon book bindings, manuscripts, clothing and glossy paper with starch sizing. Syrup and other sweets are attractive also. The adults can survive two or three months without food, but they can only live a month without water.

Oriental Cockroaches



Description: Oriental cockroaches are shiny dark brown or black. Adult females are about one and one-fourth inches long, are broad, and have only little pads for wings. The wings of both male and female are nonfunctional.

The males are about an inch long, slender and bear wings which do not reach the end of the abdomen. The young generally mature in the spring. Egg cases are dropped more or less at random.

The females are generally more numerous than the males. The adults are most common during May and mating is more frequent during this period. The mating peak for this species is more well defined than in other species of cockroaches.

Habits and habitat: The nymphs and adults have similar habits and are found associated with decaying organic matter indoors and out. They can be found in yards, beneath leaves, in dumps and in the mulch of flower beds. They are also common in high moisture situations such as sewers, drains and dark damp basements. Both the nymphs and adults are sluggish and are usually located at or below ground level. They are seldom found on walls, in high cupboards or in the upper floors of buildings.

Feeding: They feed on all kinds of filth and rubbish and other decaying organic matter. They seem especially fond of garbage and the contents of discarded tin cans. They can live for a month without food if water is available, but die within two weeks without water.

CRICKETS

Crickets are occasional pests of homes and other buildings. They normally breed outdoors but sometimes enter structures when attracted by lights, when searching for a hibernating place, or by accident. Usually only a few individuals enter a structure, but outbreaks sometimes result in large numbers appearing on and within buildings.

Two species are most troublesome—field crickets and house crickets. The habits of these two crickets are different and require different types of treatment. Therefore, it is important to be able to distinguish between the two.

The House Cricket

Description: The house cricket is light, yellow-brown or straw-colored, with three dark bands on the head. The body of the adult is about three-fourths inch long. This cricket is found throughout the United States, but is a pest primarily east of the Rockies. The long ovipositor shown protruding from the end of the abdomen of the females is used only for laying eggs. It is not a stinger and it can't break the skin of a human. Males (not shown) have only the two tail-like bristles or cerci on the end of the abdomen. This is true of all crickets.

Habits and habitat: All stages can live in buildings the year round, but during warm weather house crickets breed out-of-doors, especially in garbage dumps where some of them also spend the winter. The eggs are deposited in cracks and crevices in dark places or behind baseboards. A female lays from 40 to 170 eggs. The egg stage lasts 8 to 12 weeks and the nymphs develop into adults 30 to 33 weeks after hatching.

House crickets normally are found in warm, dark places in structures. They hide in cracks during the day and come out and feed at night. The adults are attracted to lights and will fly or travel on foot. They are good jumpers. They have been known to crawl up buildings and enter third-story windows.

The Field Cricket

Description: The field cricket varies in length from three-fourths to one inch. The color is usually dark brown to gray to black, but occasionally light brown specimens are seen. This species also flies and jumps. Field crickets are found throughout North America.

Life history and habitat: In the northern states about 95 percent of the field crickets overwinter as eggs in the ground, and the rest pass the winter as half-grown nymphs under leaves, trash, and other debris. The eggs hatch in May and June after which it takes from 9 to 15 weeks for the nymphs to complete their development. Adults are present from late July to the first heavy freeze. In late August and September, eggs are laid singly in the soil at depths of from one-fourth to one inch. Each female lays from 150 to 400 eggs. There is but one generation per year in the North. In the South this species overwinters as nymphs and is active the year round. There may be as many as three generations per year.

Field crickets prefer to live out-of-doors where they feed on soft plant parts. When they become abundant or when the grasses dry up, they migrate and may invade structures. Field crickets are apparently not able to adapt themselves to conditions in houses and eventually die off by early winter.

Economic Importance

Outdoors, crickets often damage crops and garden plants. Indoors they sometimes feed on linens, rayon, furs, paper and all kinds of foods and even rubber. Clothing stained with perspiration is especially subject to attack. Unless large number of crickets are present, such damage is usually very minor and goes unnoticed.

Crickets are primarily a nuisance in the home. The housewife does not like to see them and their chirping is often annoying. The sound is made only by adult males and is produced by rubbing the front wings against one another. The sounds are used as mating calls, danger signals, or merely to indicate the cricket's presence.

EARWIGS

You may often receive calls from homeowners in warm weather about insects around baseboards at ground level. These may very well be earwigs which are readily recognized by the forceps-like appendages at the end of the abdomen. These insects live outdoors but occasionally invade homes, becoming a temporary pest but not becoming established. Identification is important because insecticide effectiveness varies among species.

Description and General Biology

Adult earwigs are flattened insects, up to one and one-fourth inches in length, and light red-brown to black. Some species are wingless but others have a pair of leathery forewings covering a few segments of the abdomen and the membranous hind wings, which have the tips protruding.

The forceps-like appendages at the end of the abdomen are strongly curved in the male. The female's are smaller and less curved. The forceps are used primarily for defense and during courtship and cannot harm man.

Eggs are laid in small batches or clutches in a chamber two to three inches beaneath the soil surface. The mother guards the eggs and the newly hatched young. After the first molt, the young leave the nest and fend for themselves.

They differ from the adults in color pattern, forceps' shape and size, lack of wings, and in body size. The young usually mature in one season and most species in this country have one generation per year, overwintering as eggs or adults in the soil. Eggs and young require moisture. Heavy rains are detrimental to both forms as are rapid temperature changes. Some young tunnel as deeply as six feet to escape the cold.

Habits and Habitat

Earwigs are active at night and some species are attracted to lights in large numbers. During the day they usually find shelter beneath stones, boards, sidewalks, or debris. Earwigs are rapid runners and migrate short distances in this manner. Only a few of the winged species are good fliers. They are often transported great distances in plant materials and occasionally in other freight.

Economic Importance

Earwigs are primarily scavengers on dead insects and rotted plant materials. Some species are predators; others feed on living plants and often become pests in greenhouses and field crops.

BOXELDER BUGS

Boxelder bugs are nuisance pests in suburban and rural areas in most of the United States. These striking, red and black true bugs are plant feeders and use structures only for shelter. A recent test indicates that dieldrin is particularly useful in the control of boxelder bugs.

Description

Boxelder bugs are red and black insects which cluster on boxelder trees during summer and fall and move to structures for shelter during the onset of cold weather. They are about one-half inch long, dark brownish gray to black with red markings. They are rather flat and their forewings overlap on their backs. The rear half of the front wings is thin and membrane-like, whereas the foremost half is hard and thick.

The adult boxelder bug has three bright red lines running lengthwise on the thorax. Also, there are conspicuous red lines on the hard parts of the wings.

The minute red eggs are laid in cracks and crevices, in the bark or on other parts of female boxelder trees. They are laid in the spring and may also be present later in the summer in warmer areas where more than one generation of the boxelder bug occurs.

The young or nymphs of the boxelder bugs are wingless, but not generally similar in shape to the adults. They undergo five molts. The smaller stages are solid bright red, but the larger ones have some black markings.

Life History and Habitat

Boxelder bugs seldom, if ever, develop sufficient numbers to be nuisances unless they are able to feed on female boxelder trees. Apparently they thrive on the seeds which are not present on the male boxelder tree. Therefore, it is very important to be able to identify this tree so as to locate breeding sites of the bugs.

The boxelder tree, also known as ash-leaf maple or three-leaf maple, is native to most states except those in the Southeast. It is most common throughout the Midwest as an ornamental or shade tree and it is sometimes used as a screen or windbreak.

Boxelder bugs pass the winter in the adult stage in protected places as in houses or other structures, but also in stone walls, tree holes and large accumulations of debris. They appear on sunny, warm locations on warmer days throughout the winter, particularly on white or light painted surfaces. In the spring, when the buds open, the bugs leave their winter quarters and seek out the host trees on which to feed and lay eggs. In warmer areas of the country, there appears to be two generations.

When the weather turns cold in the fall, the adult bugs and large nymphs cluster together and travel about seeking suitable hibernation quarters for the winter. Usually they move by crawling but the adults are capable of flight occasionally do so.

Boxelder bugs are plant feeders and, therefore, do not feed on structures, food products, etc.

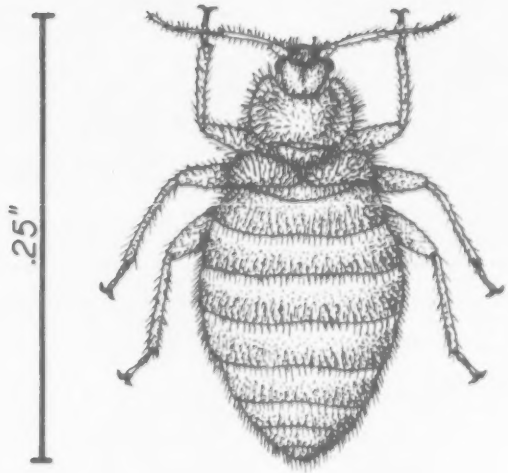
When hibernating indoors, the bugs may stain curtains, paper and similar objects with fecal spots. They produce a foul odor when crushed.

Control

The most satisfactory and permanent method of control of boxelder bugs is the removal of the female boxelder trees. In areas where boxelder bugs are a common problem, customers may be advised against planting the female trees. Male trees can be obtained from nurserymen who propagate them by taking cuttings only from staminate (male) trees.

Ordinances have been passed in some areas making it a nuisance to maintain female boxelder trees. In this case, city-owned female boxelder trees are removed at city expense and authorized employees are permitted to make inspections on and remove specimens as necessary from private property. After appropriate notice requiring the removal of female boxelder trees, the local government may cause their removal at the expense of the property owner.

BEDBUGS



Description

The common bedbug is an oval, flat, reddish-brown insect about one-fourth inch long. They are practically wingless and flattened, so that they are capable of hiding in cracks, behind baseboards, or under loose edges of wallpaper and carpet edges. The young (nymphs) resemble their parents. Bedbug eggs are whitish, big enough to be seen, and are usually fastened into corners and cracks used by the adults.

Bedbugs are commonly found in old buildings, hotels and boardinghouses. Usually they are found in sleeping rooms, for they feed at night when they can, but in theatres, buses and offices or when starved they will feed in the daytime.

Feeding

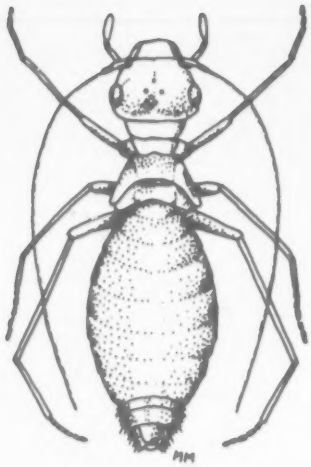
Blood is their only food. They take it from rabbits, mice, rats and other animals as well as man. Since the wounds they make may continue to bleed after bedbugs stop feeding, sheets or mattresses in infested sleeping quarters may show blood-stained spots.

Bedbugs can live for nearly a year without a blood meal, but they cannot reproduce after long periods without food.

Other blood-sucking pests of man that are apt to be mistaken for the common bedbug:

Species	Distribution	Description	Where Found
Bat bug	Probably general. Reported from Delaware, Indiana.	Bed clothed with fairly long hairs, 2nd and 3rd segments of antenna of equal length.	In attics frequented by bats; crawl into heated rooms and attack man.
Swallow bugs	Eastern states through Middle West	Light yellow to amber in color	In homes, from areas inhabited by swallows

BOOKLICE



The customer will often describe an infestation of booklice as "hundreds (or thousands) of small pale insects walking over walls, furniture and other materials." You will receive most booklice calls during the summer or early fall months from occupants of new buildings. Booklice may create problems in any type of account at any time of year. Infestations are usually associated with high humidity. Booklice are not true lice and do not injure man. Booklice are so named because they often live among books and papers. They are also known as psocides, barklice, and deathwatches.

Description

Several species of booklice infest structures. You seldom need to know the species to obtain control Most are wingless or have only small wing scales. They are about one-sixteenth inch in length and are pale gray, tan, or yellow-white. They walk about in a halting manner and sometimes "hop." They have chewing mouthparts.

Indoor species prefer temperatures of 75°F. to 85°F. and high relative humidities (75-90 percent). They usually avoid light.

Habits and habitat

Booklice usually feed on microscopic molds and live in humid environments. New construction often provides these conditions. Green lumber is used and the structure is quickly enclosed so that little drying occurs. This creates "sweating" and high humidities in wall voids and molds often form. After the building has been heated one season, the structure dries enough so that the infestation seldom reoccurs.

Damp basements, leaking roofs, and leaking or sweating plumbing occasionally create local moisture conditions that could lead to booklice infestations.

Other less common sources include bird nests, bee and wasp nests, damp straw mattresses and furniture stuffing of vegetable origin, paste on book bindings, and damp cereals.

Feeding

Booklice feed mostly on molds. Some feed on cereals—either on the starch or on microscopic molds growing on the cereal. The starch in book bindings is eaten. Booklice do not feed on paper but they will feed on the microscopic molds which grow on paper stored in damp places.

Control

Inspect the premises to locate the cause of the infestation. If no moisture source is obvious, ask the customer if a previous condition existed which might have provided proper conditions. The source should be removed or corrected if you want good control. Insecticidal treatment is usually only a supplement to correcting the moisture condition.

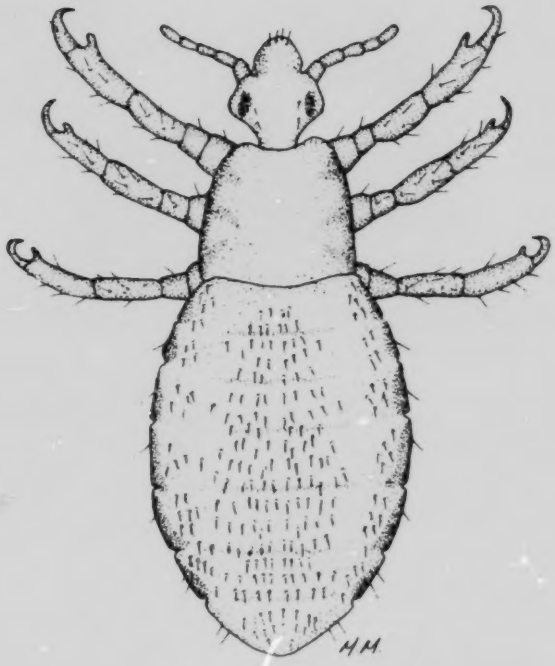
Removing the Source

If the building is new and the infestation seems widespread, then the source is probably mold in the wall voids. There is no practical means of removing this source. The condition will usually be corrected after the heat is turned on in the fall.

You can usually correct moisture conditions in crawl spaces through proper ventilation. Dehumidifiers will usually dry damp basements enough to prevent molds. Correct plumbing or roof leaks if they contribute to the problem.

If bird nests or other vegetable materials appear to be the source of booklice infestations, they should be removed.

HUMAN LICE



Human lice infestations are reported to be increasing in the United States and seem to be associated with long hair and communal living. The information that follows about these insects will enable you to answer customer's questions. You should not get involved in treating human lice infestations--it is a job of a nurse, physician, or other medical specialist.

Types of Human Lice

The three distinct types of sucking lice found established on humans are the head louse, body louse and the crab louse.

The head louse and body louse are difficult to tell apart. The adult is from one-sixteenth to one-eighth of an inch long. The color varies from dirty white to dark gray. The crab louse is only one-sixteenth of an inch and dirty white to pale pink.

The young and adults of all three types suck bood from man. The one-sixteenth eggs (call nits) are cemented to hair or clothing. The nits are very difficult to remove and empty ones remain as evidence of recent infestation.

Transmission

The ways in which lice travel from one person to another are still largely a matter of conjecture. Most infestations are usually acquired by moderately intimate association with an infested person.

Head lice can be spread by the shared use of a personal item such as a hat, hairbrush, comb, wig, or towel. Body lice can be acquired from bedding used recently by an infested person. People sleeping or huddling together in their clothing present an opportunity for the lice to spread. Crab lice are probably transmitted from one person to another during sexual intercourse. They may be (but rarely are) spread by loose hairs left on bedding and toilets by infected persons.

Control

Control requires treating the body or clothing of the infested person. Treating the premises is seldom if ever called for. You should not treat humans or their clothing. Recommendations for control procedures should be left to medical or health department personnel.

Head lice and crab lice can be controlled by applying an insecticidal dust or shampoo registered for such use. Dusts must remain in place for several days and are unsightly. There are liquid preparations available which may be washed out 5-15 minutes later. One application usually suffices.

Body lice usually can be controlled by laundering or dry cleaning infested undergarments and bedding. The adults are killed in five minutes and the nits in ten minutes in 125° water. With frequent changes to properly laundered clothing, an infestation will eventually end without insecticidal treatment.

GROUND BEETLES

The term "ground beetles" refers to a worldwide family of beetles, the family Carabidae. These beetles do not damage structures or household goods and do not breed indoors. When adult ground beetles do come indoors, they are nuisances and are sometimes confused with cockroaches or beetles that do live indoors.

Description

Ground beetles range from one-sixteenth to one and three-eighths inches in length and have a characteristic shape. Most species are shiny black in color, but some are red-orange, metallic blue or green, or have bright markings. Their legs are long and well adapted for running.

Ground beetles have hard wing covers (elytra) that meet in a straight line and that usually have ridges running lengthwise. They are easily distinguished from cockroaches whose fore-wings, although thickened, are softer, without ridges, and overlap one another. The ridges on the wing covers and the shape of ground beetles will serve to distinguish them from black carpet beetles.

Habits

Ground beetles are found in the soil, under stones, in moss and rotting wood, and under bark, etc. They are rapid runners, but fly rarely, if ever.

The adults and larvae of ground beetles are generally predacious, feeding on the larvae of other insects or on any other animal small enough to overpower. A few species also feed on plant seeds in the soil. The larvae are only seen, but the adults are attracted to lights and can often be seen on lighted sidewalks at night feeding on other insects which have fallen after being attracted to the lights.

Ground beetles lay their eggs in the soil. The small species have several generations each year, but the large species may require more than a year to mature. The larvae hide in or on soil under debris. Ground beetles do not reproduce indoors.

Adult ground beetles wander indoors if the soil becomes too wet or dry, or if food becomes scarce. They are also attracted to lights, and those that fly often enter through open unscreened lighted windows at night. Other species may be attracted to lights near doorways and enter through cracks under doors.

Control

Removing debris such as old boards, stones, trash, piles of leaves, etc. from around a building reduces the ground beetles' (and other insects') hiding places and protection from insecticides.

If ground beetles and other insects are attracted to the building at night, the problem can be reduced through proper light management. Lights should not shine directly on the building. Lights near doorways should be yellow since yellow light is less attractive to insects than are other colors.

ELM LEAF BEETLE

The elm leaf beetle is an occasional household pest that has been reported from much of the United States. Although the adults enter buildings for shelter in the fall, they are most troublesome in the spring when they emerge from hibernation indoors. They do no damage in homes, except perhaps for staining curtains, but occasionally they occur in sufficient numbers to become serious nuisances.

The elm leaf beetle is an insect of European origin, but it has been in this country for more than a century. It will undoubtedly spread to wherever elms occur in the United States, but it seems to be much more numerous in urban areas.

Description

The adult elm leaf beetle is about one-fourth inch long and with characteristic markings. Newly emerged individuals, which may be found during the summer and fall, are mostly light yellow, with the stripes olive green to black. As the insect ages, these colors darken, so that in the spring the beetles may be a dull olive green with indistinct black stripes. The two spots on the head and the thorax are black. The eyes are black and the antennae and legs, yellowish.

The eggs are orange-yellow and they are laid on the undersides of elm leaves. The newly-hatched larva appears nearly black. The full-grown larva, which is about one-half inch long, is dull yellow with two black stripes down the back. The pupa is about one-fourth inch long and bright orange-yellow with a few black bristles.

Life History

Elm leaf beetles pass the winter in the adult stage in buildings, in crevices in bark on trees, or in debris near the base of the tree. In the spring, they fly to nearby elms and begin feeding on the new leaves. Although all elm species are subject to attack, the beetle prefers Chinese elm. Egg-laying begins in late April in the southern range of the beetle and in late May or early June in the northern areas. Each female lays from 400 to 800 eggs in groups of 5 to 25 on the underside of the leaves. The eggs hatch in about a week. The larvae feed on the leaves and mature in two or three weeks. These larvae then pupate in sheltered places at the base of the tree such as under stones, grass and leaves, in cracks in sidewalks, or under the bark scales of the trees itself. The new adults emerge about 10 days later. They often disperse over distances of several hundred feet and may wander indoors.

In the southern part of the country there are two and sometimes three generations each year. In the north there may be a second generation, but a third is rare. The first generation usually does greater damage to the trees than any of the generations that may follow that season.

Habits

Homeowners may notice the beetles when heavy infestations cause the leaves on the elm trees to dry up and drop prematurely, but most don't notice the beetles until they get indoors. The indoor problem is greater in the north. In the fall the adult beetles may enter through cracks in shingles, unused fireplaces, or windows, and hibernate in wall voids or attics. When suitable shelter is found, they remain dormant throughout the winter, and the homeowner seldom notices them. In the spring the beetles become active and are attacted to light. The homeowner becomes aware of their presence as they cluster to windows, trying to get outside. Elm leaf beetles are sometimes confused with carpet beetles which also cluster at windows in the spring.

Control

Control of the beetles in and around the home is difficult since the infestation is constantly being renewed. Dusts should be applied around the foundation of the home to prevent beetles from entering. Household sprays will kill those already in the home.

WEEVILS INVADING HOMES

Several weevils that feed outdoors on plants, occasionally invade homes. They don't damage structures, but sometimes enter them when wandering or when searching for hibernating places.

Description and Distribution

Weevils are beetles, but unlike other beetles all weevils have snouts. They have egg, larval, and pupal stages. Most weevils can fly, but there are a few that cannot fly. Those that live outdoors but occasionally invade homes are listed below.

The black vine weevil is found throughout the northern United States. The adult has a very roughened appearance and is shiny dark brown or black with yellowish patches on its back. A related species is found further south and does not have yellow patches. The strawberry root weevil is similar in appearance, but has the same distribution as the black vine weevil. These

three weevils cannot fly. They feed on a variety of plants including foundation plantings such as yew, hemlock, rhododendron, azalea, and maidenhair fern.

Life History and Habits

The biology of all the above-mentioned weevils is similar. The adults feed at night on the foliage of plants, leaving a scalloped edge on the leaves of broad-leaved plants. They hide beneath debris or in the soil at the base of the plants during the day. The eggs are dropped on the soil surface, and the young larvae burrow downward to feed on the rootlets of the plants. Generally, there is one generation per year, although occasionally there may be two. The weevils overwinter as adults in debris or as papae beneath the soil surface near the host plants.

These weevils become nuisances by wandering indoors apparently when searching for suitable hibernation or feeding sites. This usually occurs in the fall, but has been noted in late spring or midsummer as well. Once indoors, they may be found, particularly during early evening, crawling over the floor. At other times, they hide under rugs or in other concealing places. It has been noted that they are frequently found around indoor moisture sources.

Distinguishing Occasional Invaders from Other Weevils Found Indoors

There are several species of weevils found indoors that are not occasional invaders. The commonest ones are the grain-infesting species: the granary weevil, *Sitophilus granarius*, and the rice weevil, *S. oryza*. The occasional invader species are rough in appearance or are covered with scales or hairs while those weevils that can live indoors are always smooth and without scales or hairs. The grain-infesting weevils are "straight-sided" in contrast to the irregular outline of the occasional invader.

ANTS

Description

Of the many kinds of ants, only a few species are pests in buildings. Two features distinguish them from other small insects with which they are likely to be confused. Ants have wasp-waists; that is, their body is very thin where the abdomen and thorax join. In addition, their antennae are elbowed, meaning that each feeler looks like an arm bent at the elbow. These two features, the wasp waist and the elbowed antennae, apply to both the wingless and winged forms of ants. The fully winged adults swarm often in great numbers and over wide areas on a single day. The same is true of termites, with which winged ants are often confused. Termites have four wings all of about the same size, while the front pair of wings on ants is much longer than their rear wings. In additon, termites' bodies are about the same width from end to end but the ant's bodies are clearly constricted in the middle so that the front end and the rear portions appear to be joined by a thin "stem." Ants may vary in length from about one-sixteenth inch to more than one-half inch. In some species you may find wingless workers of different sizes in one colony.

Biology

Like bees and termites, ants are social insects. They live in colonies consisting of different types of individuals. These different types are called castes. Ants normally have three distinct castes: workers, females and males.

The male is generally winged and keeps its wings until death. It is usually larger than the worker but smaller than the queen. The male differs from the winged female by having the genital appendages protruding from the abdomen and extraordinarily large eyes which are out of proportion to the head. Apparently, the only function of the male is to mate with the unfertilized female, after which the male dies. Mating may take place in the nest, on the ground, or in the air. Males are produced only in old or very large colonies. Adult males do not remain in the nest long and may succumb to predators and the elements without mating.

The female is generally the largest of the three castes. She normally possesses wings but loses them after mating. Her eyes are well developed, her thorax is large and her abdomen is enlarged for the production of eggs. The primary function of the female or queen is reproduction, but she may care for and feed the first brood of workers on her salivary secretions. A queen normally mates only once in her lifetime. She may live for many years. A daughter queen may replace her when she dies. Most species have only one queen per colony, but colonies of some species may have many queens.

The worker is a female whose reproductive organs have not developed. Rarely are they winged; they normally lack ocelli (males and queens have them), but they have compound eyes. Workers are not always the same size in a given species. When the workers of a species are approximately the same size and structure, the species is called monomorphic (one form). An example is the Argentine ant. When workers of one species are of two or more sizes and types, the species is called polymorphic (many forms). An example is the black carpenter ant. Large workers with well-developed mandibles are called soldiers. The function of the worker is to construct and repair the nest, find food and feed the immature and other adult ants in the nest, care for the eggs and young and defend the nest. Under certain situations, the workers can produce eggs. These eggs can produce workers, females and males.

Ants have four developmental stages: egg, larva, pupa and adult. The egg is almost microscopic in size and varies in shape according to the species. On hatching, it produces a soft, legless larva. The larva is usually more or less translucent, gourd or squash-shaped with the head at the narrow end. After feeding and several molts, the larva pupates. The pupa resembles the adult, but it is soft, white and does not move about or feed. In some species, all of the pupae are naked; in others, the pupae are enclosed in silk cocoons; and in others the pupae may be naked or in a cocoon. The pupae, especially those in cocoons, are commonly called "ant eggs" and are sold in pet shops under this name. If a stone or board under which a colony is living is moved, the adults can be seen carrying the pupae (or "ant eggs") and larvae off; and if one looks closely enough, the ants can be observed carrying the true eggs which are very tiny.

The adult may require a few days to attain complete maturity after emergence from the pupa. During this period, the body of the adult becomes hard and attains the color of a mature adult. Six weeks to two months or more are required for development from the egg to the adult stage. The time varies according to the season of the year, the temperature and the species.

One of the most common methods of establishing a new colony is for a fertilized queen (after losing her wings) to construct or locate a ready-made cell or cavity in wood or soil. She then seals the chamber closed and rears her first brood by herself from the nourishment supplied by her salivary glands. The small, undernourished workers of the first brood open the nest and bring in food from the outside for themselves, the queen, and future broods. As the colony grows in size and strength, more and larger workers and males and females are produced. This may require from three to five years or more and the colony may persist for many more years.

Some species of ants form a new colony by a process called budding. This occurs when a daughter queen, which has been fertilized in the nest, leaves the nest with a number of workers and establishes a new colony. Queens of some species may move into the nest of another species using its workers to help raise the first brood.

Feeding

Ants require water for drinking and will travel some distance for it if necessary. Ants living outdoors drink dewdrops. The workers are able to bring water back to the nest for the young and queen in their stomachs.

Economic Importance

Ants may affect man adversely by stinging and biting, by nesting in lawns, golf courses and premises, by stealing seeds from seed beds, or by feeding on germinating seeds, by defoliating or gnawing into plants and plant products, fostering other injurious insects, such as plant lice and mealy bugs, by gnawing holes in various types of fabrics, removing the rubber insulation from telephone wires or other equipment, killing young poultry, birds or game; by annoying man or his animals by their presence, and possibly by transmitting certain human diseases in crawling over sputum, feces, carrion etc. However, only a small number of species or forms are involved, most ants being neutral or even beneficial.

WASPS

The wasps include those forms which the layman knows as mud-daubers, yellow jackets, hornets, digger wasps, common wasps and paper wasps. The winged forms have four wings, although it may require careful examination to see this, for the front and hind wings on each side are hooked together to function as a single wing. They are closely related to the bees, and like them, the ovipositor or egg-laying structure of the female is modified to form a stinging apparatus. They differ from the bees in that they feed their young on animal matter such as insects or meat particles and not on honey and pollen.

Among the wasps we have species of very different habits. Some are "social" wasps and others are "solitary" wasps. The social wasps are those that develop a "family" unit. The mother or queen remains with her eggs and then feeds her young. These, in turn, as they mature, take over the major duties of foraging for food, caring for the subsequent broods of developing young, and building additions to the nest. The solitary wasps do not develop a family group. The female builds a cell or nest for each egg that she lays and provisions each cell with food for the developing larva. In most species sufficient food is provided for complete development of the larva at the time the egg is

laid, although some species may feed their larvae several times during development.

All of the social wasps belong to the family Vespidae and are commonly referred to as the vespid wasps. This group includes the hornets, yellow jackets, and paper wasps—all of which are social in habit. Some vespid wasps, however, are solitary in habit.

The solitary wasps most commonly encountered by our industry belong to the family Sphecidae and are known as sphecid wasps. The mud-daubers and digger wasps belong to this group.

(The Social Vespid Wasps (Paper Wasps, Hornets, Yellow Jackets)

Many of the Vespid or social wasps build nests of paper from fibers of weather-beaten wood or dead plants which are worked into a paste with saliva in the jaws of the adult wasp. In the temperate regions these nests are used only through one season. All workers and males die in the fall. The fertilized female hibernates through the winter in some protected location, often in walls or crevices of a house. In the spring the female emerges and seeks a place to

start a nest for the establishment of her family through the coming season. It is the emergence of these females seeking nest-building sites that is the cause of many of our calls for control of these species early in the season.

In most of our temperate-zone species the female selects her site, starts her new nest, and rears the first brood of her offspring to adult workers without help. In one species, the young queens often return to their home of the previous year where they visit with their sister queen and then set out as groups of queens to set up a new colony. The presence of more than one queen in a colony is more common in tropical species, which build huge nests, than in the temperate-zone species.

The choice of nesting site apparently depends on the instinct of the species. Some of the *Polistes* wasps like the eaves of houses; others a tree-top; still others prefer the darkness of a hollow tree or the walls of a building or an accessible attic. The bald-faced hornet, which builds a large nest, always selects an aerial location as a limb of a tree or under a porch or in a barn. The yellow jackets most commonly build their nests in cavities in the ground, although they may sometimes be found under eaves. The giant hornet builds in hollow trees or logs or within buildings.

The nests vary greatly in size and construction among the species. *Polistes* wasps make open, single-layer nests, while the hornets and yellow jackets make covered nests of many layers of cells.

After construction of the cell of the nest, the queen carefully lays an egg in it. On hatching, the larva is provided with food. The food for the larvae is meat, either from caterpillars or other insects, or from bits of other meat (fresh, cooked, or decaying) that may be found. The food of adults is liquid, as fruit juices, flower nectar, honeydew, and juices from the bodies of the insects and spiders fed to the larvae. Until the first brood of workers has matured, this is done by the queen but as soon as workers (all sterile females) appear, this duty is taken over by them.

The males do not appear until they are needed in the fall of the year for the fertilization of the new queens which are developed for overwintering.

Soon after the new queens have been produced, the rest of the colony dies out.

The Solitary Sphecid Wasps (Mud-Daubers and Digger Wasps)

Many types of nests are built by the numerous species among this group. Some build nests of mud; other burrow in the ground or in plants. In most cases the female carries out all of the work of building the nest and supplying the food for the larvae. The fertilized female constructs a cell, either individually or in a nest, and collects the necessary food (spiders, caterpillars or other insects), stings them and places them in the cell. She then lays an egg on the food and seals the cell. Thus, when it hatches, the larva has a supply of food on hand, which will support its full development. It pupates in the cell and emerges as an adult.

The black and yellow mud-dauber: The common black and yellow mud-dauber builds nests of mud, sometimes of single cells but most frequently of several cells side by side. This wasp is commonly found in our attics, porches and out-buildings. The adult is common in moist places such as mud puddles from which it carries balls of mud for its nests. It collects only spiders as food for its young. The cell is packed with spiders, paralyzed from the wasp sting, and a single egg is placed in the cell which is then sealed by mud. There are commonly two generations a year with this species and the winter is passed as a cocoon in the nest.

The blue mud-dauber: The blue mud-dauber is always found closely associated with the black and yellow mud-dauber. And for a very good reason, too! She will not build her own nest, but occupies only those built by her black and yellow cousin. She softens the mud on the nest, opens the cell, removes the stored spiders, cleans the cell carefully, and then stores her own spiders and deposits her own egg.

The Blue Mud-Dauber

1"

The cicada-killer: Another common pest form of this group is the cicada-killer wasp. This is a huge black wasp with yellow bands on its abdomen. The adults dig burrows in lawns, terraces or banks, causing unsightly mud piles. Each burrow may have several cells, each of which is stocked with at least one paralyzed cicada on which an egg is deposited. Sometimes two cicadas are placed in a cell. In two or three days the larva hatches and in about two weeks the larva is full grown. It then constructs a cocoon in which it stays until the next year in June or July when it pupates and emerges as an adult. This species causes considerable concern when it is active, for it is capable of disfiguring a lawn and its large size frightens anyone from approaching the area to do anything about it. Its sting is reported to be painful, although these wasps have not been reported to sting unless they are molested.

BEES

Description: Honey bees may be various shades of yellow, black or brown; the head, antennae, legs, and a portion of the abdomen are dark. The body is covered with dense buff or pale hairs, thickest on the thorax and thinnest on top of the abdomen. The workers, one-half to three-fourths inch long, have wax glands on the under side of the abdomen. The honey bee is a social insect and lives in colonies of 20,000 to 50,000 individuals. There are three castes: queen, drone (male) and worker. The queen produces the eggs for the colony and may lay as many as 1,5000 per day. Incubation lasts 3 days. Worker larvae transform to adults in 21 days: queen larvae, in 15 days; and drone larvae in 24 days.

Habits and habitat: At times honey bees build their nests in houses or so close to houses that they become pests of man. They may enter through knotholes or cracks to build between the outer and inner walls, or they may construct their nests inside of chimneys, under eaves, and in similar spots. Since weather often affects the temper of bees, they are likely to sting on a cloudy or cool day, when they are unable to fly and forage for food. During the winter adults in the colony remain active.

Economic importance: The honey bee, a cosmopolitan species, is one of our most beneficial insects. Besides the part it plays in the production of honey and wax, it is one of the chief pollinators of plants. On certain occasions, however, honey bees become a distinct nuisance, particularly when they nest near or in a home and sting man.

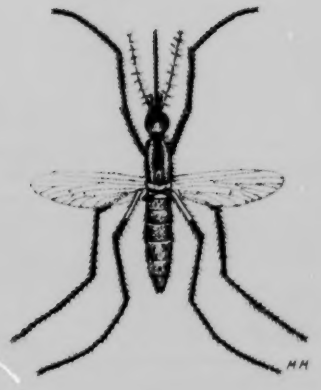
Carpenter Bee

Description: The large, heavy-built adult greatly resembles a bumble bee, but differs from it by having a broad head with tan to brown edge and a blue-black almost metallic appearing abdomen. Other characteristics include the dense brush of hairs instead of a pollen basket on the hind legs of the female, and the lower part of the face yellow on the male. The thorax is entirely covered with fine yellowish hair. In northern latitudes eggs are laid singly in late April and early May. The adults, which develop from these eggs, emerge in July and August. Both the adult males and females hibernate during the winter, becoming active again in April. In southern states these bees may be active throughout the winter months.

Habits and habitat: This bee builds its nest in wood, cutting a tunnel one-half inch in diameter and often as much as a foot long. These tunnels are sometimes cut in dead branches and fenceposts, but are most common in homes and barns where the bees bore into outside roof rafters, gutter boards, beams and plates. In such instances, the bee enters the side of the timber and then cuts a 90-degree turn, completing its passage lengthwise within the wood. The entrance may divide inside the wood and turn at right angles in both directions forming a T. The entrance may also be at the cut end of a board, in which case no turn is made. The tube, which eannot be seen from the outside, is divided into several cells, each provisioned with a pollen mass and partitioned from the adjacent one with chips of wood cemented together. This arrangement is somewhat spiral in form and a single larva occupies each cell in the nest. Activity of the adult bees is considerable and the bees may be seen frequently entering and leaving the nests.

Economic Importance: Carpenter bees constitute both a hazard and a nuisance when considerable numbers of nests are sometimes built in a single board, thereby weakening it. The female bees can sting, but seldom do. They can be numerous enough around a yard, however, to constitute a real annoyance. Distribution of *X. virginica* is widespread in the eastern and middle part of the United States, but certain other species are more numerous in other parts of the country.

MOSQUITOES



General Characteristics

Mosquitoes belong to the order Diptera, family Culicidae and, like other flies, have but two wings. They are characterized as small, soft-bodied flies with long, slender abdomens, narrow wings with scales along each vein, and mouth parts prolonged into a proboscis. In the females the mouth parts are modified for piercing or sucking. The males are incapable of piercing and, therefore, suck no blood.

Life History

For convenience in considering characteristics, we divide the mosquitoes into two general groups, culicine and anopheline. Only the mosquitoes known as Anopheles are considered in the latter group, while all others are included as culicine. Development of all mosquitoes is complete: egg, larva, pupa and adult. Eggs are laid on or near water. A blood meal is required by each

female before viable eggs may be laid. The anopheline eggs, which are laid singly, are equipped with lateral, air-filled floats; culicine eggs are laid in rafts or singly at the edge of water or upland where water will later flood and hatch them.

The larvae, or "wiggle-tails," always live and develop in water. Although the larvae have gills, oxygen is received principally from the air above the water surface by means of an air tube or open spiracle. The anophelines are distinct in being surface feeders and go to the bottom principally for protection only. All mosquito larvae pass through four stages, or instars; only in the fourth instar are they large enough and well enough developed for reliable identification. Larval food consists of minute plant and animal life and fragments of debris. Some larvae are predaceous on other insects.

The pupal stage of mosquitoes, unlike that of most other insects with complete metamorphosis, is an active stage. Breathing takes place through two respiratory trumpets. Mosquito pupae do not feed, but they will leave the water surface when disturbed. Differentiation of various species in the pupal stage is difficult.

The adult anopheline mosquitoes can be distinguished from the others by lack of scales on the abdomen, by the palpi of the female, which are as long as the proboscis, and by the fact that the wings usually have distinct dark markings. It is important that when the anopheline female feeds or rests, the position of the body makes an angle with the surface of at least 45^{o}. The culicine body is always parallel to resting and feeding surfaces.

Control

Good area mosquito control begins with reduction of breeding places. Typical standing water sources such as automobile tires, rain puddles, small buckets, etc. should be eliminated by filling or by draining.

In areas with heavy mosquito populations, openings in inhabited buildings should be tightly screened. Screening with 16 mesh to the inch will keep out most mosquitoes, but 18 mesh may be necessary for some small species.

MOTH FLIES

Each year, PCO's receive calls from homeowners who have small, mothlike insects on the walls of their bathrooms, kitchens or in the basement. They generally turn out to be moth flies. These flies do not bite and are of no economic importance. Even those which breed in sewage beds apparently do not transmit human diseases. These flies are a nuisance, though, in both homes and sewage disposal plants. The adults can become so numerous around disposal plants that they plug filter beds, intakes and drains and get into the eyes, ears and noses of workmen in the area.

Their accepted common name is moth flies, but they are also called drain flies or filter flies. There are several species involved, but none has a common name. The commonest in homes is *Psychoda alternata (Say)*. This species is widespread and the adults usually begin emerging in the early spring.

Description

The adults of all the species are similar in appearance. They are small, fuzzy, dark-colored or grayish insects about one-tenth inch in length. The body and wings are densely covered with hairs and the wings are held roof-like over the body when at rest.

The larvae are legless and wormlike. They are gray in color with both ends somewhat darker. The mature larvae are about three-eighths inch long.

The eggs are very tiny, cream or brown colored, and are laid in irregular masses of 10 to 200.

Life History and Habitat

Moth flies breed in polluted shallow water or highly moist organic solids. Eggs, larvae and pupae may be found in the muck or gelatinous material which accumulates on the sides of drains and overflow pipes in homes or in sewage disposal beds, septic tanks and compost. Occasionally, they may occur in dirty garbage containers, birds nests (with accumulations of moist excreta), tree holes and rain barrels.

The eggs are laid in or on the breeding media, but are never wholly

submerged in it. They must be kept moist to hatch. Hatching occurs within 14 to 48 hours, depending upon conditions and the species involved.

The larvae usually feed on the surface of the media; but in filter beds which are treated regularly with chemicals, the larvae feed in or on the undersurface of the floating sediment. Their food consists of decaying organic matter and the microscopic plants and animals that occur in the media. In fact, the larvae are valuable organisms in the efficient operation of filters at sewage plants. The larvae normally have five instars and mature in 4 to 15 days, depending upon the species and the temperature. They are difficult to drown because they can trap an air bubble and remain submerged for a day or more.

The pupae are found in or on the surface of the breeding media. The pupal stage lasts for 20 to 80 hours, at which time the adult emerges.

Under favorable circumstances, the flies can go through one generation in as little as one week's time, although two or three weeks is more typical. Some activity may occur during the winter months in the south, but development usually ceases in the north during the cold months.

Habits of the Adults

The adults can mate and lay eggs the same day they emerge from the pupae. They live about two weeks. Usually only a few are seen at any one time in homes because old ones die and new ones are continually emerging. They are poor fliers and are commonly seen walking or running on walls and other resting surfaces. When they do fly, the flight covers only a few feet and is in short, jerky lines which is very characteristic of these flies. Although they are weak fliers, the adults may be carried more than a mile by a prevailing wind.

During the day, the adults rest in shaded areas or on the under-surface of leaves outdoors and on walls near plumbing fixtures or on the sides of tubs and showers indoors. Most of their activity occurs during the evening when they may be seen hovering about drains and sinks indoors and over breeding areas outdoors. They are attracted to lights and may be found on lighted windows at night. They are small enough to get through ordinary window screening

which was designed for excluding house flies.

The adults feed on nectar of flowers and on polluted water.

Control Indoors

When PCO's encounter moth flies in private residences, the flies will most often be breeding in the gelatinous material which accumulates in drains and overflow pipes of sinks and bathtubs.

Insecticides are generally ineffective against the larvae in such situations. The most effective method of control is to thoroughly clean the drain pipes and traps with a stiff brush. Sometimes it is necessary to remove the trap to clean the pipes of all the gelatinous material.

DROSOPHILA FLIES

Drosophila flies are variously referred to as vinegar flies, pomace flies, banana flies, sour flies, vinegar gnats, sour gnats, fruit flies and lesser fruit flies. So as not to confuse these with other groups, especially the true fruit flies, they should be referred to by the common name drosophila flies. They are true flies of the order Diptera, family Drosophiladae and genus *Drosophila melanogaster* Meigen, is widely used by scientists in the study of genetics and heredity.

Description

The principal economically important species are quite similar in appearance. Adults are dull brownish-yellow or brownish-black in color and from one-tenth to one-sixth inch in length. A feathery bristle on the antenna is typical of this group and helps to distinguish them from other small flies of similar appearance.

Egg: The eggs, which are laid singly, are pearly white cylinders almost too small to see with the naked eye. Under magnification drosophila eggs are readily distinguished by the two to four threadlike tubes protruding from one end.

When present in large numbers, the eggs appear to the naked eye as white film or white mold. The threadlike filaments tend to attach the eggs to the food material, making them difficult to remove by ordinary washing processes.

Larva: Newly hatched larvae are cream color and only about one-thirtieth inch long. At maturity they may reach one-fifth inch in length. Their color is determined by the food material on which they are feeding. The posterior is thick and has two tubelike stalks, each with breathing pores at the end. The body is legless and is gradually tapered toward the head end.

Pupa: Their brown, seedlike pupae are about one-eighth inch long. Each has two hornlike stalks at its front end.

Life Cycle

Eggs are deposited singly into moist food material. Most often this is damaged, overripe fruit, but it may also be any moist fruit or vegetable product, by-product, or waste material. The female lays about 25 to 35 eggs per day and may lay up to 2,000 in her adult life span of two or three months.

Eggs normally hatch in about 24 hours, although they have been observed in the field to hatch in as short a time as 2 hours. The female drosophila can retain her eggs until a suitable breeding site is located; hence, she sometimes deposits eggs that hatch into larvae almost immediately.

The larva burrows and feeds upon the food material on which it finds itself. It molts twice as it develops and pupates at the age of about 4 days. The pupal stage lasts another four days, then the adult emerges. Mating takes place very soon, usually within a few hours, and the adult females begin laying eggs about 24 hours later.

Complete development from egg to adult under summer conditions may be completed in 8 to 10 days. This rapid life cycle explains how fantastically large populations of drosophila can build up seemingly overnight.

Habits

Drosophila flies are strong fliers, having been known to travel as far as 6.5 miles within a 24 hour period. Outdoors, they are most active between 6 a.m. and 8 a.m. or 5 p.m. and 8 p.m. On cloudy and overcast days they may

remain active all day. Bright light, strong winds, and temperatures over 90°F. or under 55°F. seriously reduce fly activity.

In the field, populations build up during the summer, becoming very abundant at the time of fruit harvest, and remaining so until cold weather sets in.

Indoors, drosophila can breed throughout the winter and are frequently active at all times of the year.

Food and Breeding Media

Adult drosphila flies are attracted by fruit and other vegetable products. Such objects provide not only food but a favorable place for the females to lay their eggs. Materials in an early stage of fermentation seem most attractive. The flies will feed on freshly damaged fruit but since the females carry fungus spores and deposit them with the eggs, it is not long before fermentation develops. Fermenting materials are very favorable for larval development. Rot, caused by bacteria, and later stages of decay are not attractive to the adults nor as favorable for larval developments.

The yeast growths causing fermentation are known to be a primary attractant, although odors of the fruit itself are also implicated. Larvae have been successfully reared on pure yeast without any other food. By-products of the fermentation process, including alcohol, are also attractive to the adult flies. Recently large numbers of drosophila flies were attracted to a printing operation in a nonfood plant. An alcohol-based ink was the only explanation for this influx.

In restaurants and other food-service establishments, the places in which drosophila might be breeding are many and varied. Typical situations include a "forgotten" potato in a storage bin, an apple kicked under the shelves in a storeroom, food scraps accumulating in a dumb-waiter pit, improperly cleaned garbage cans, and endless similar examples of improper or lax sanitation practices.

"Emptied" beer, soft drink, milk or tomato catsup bottles, but with small amounts remaining in the bottom, have been reported as breeding media. Uncleaned mops and cleaning rags that have been left to sour also serve as

breeding sites. As the NPCA staff once discovered, even the moist brush in a gummed-paper tape dispenser can produce a good supply of drosophila flies. In other words, a great variety of very small breeding places can produce great numbers of these little pests.

A very frequent source of trouble is the slop basins that serve as common drains for potato peeling machines, dishwashers, mop basins, etc. An incrustation of food materials builds up on these basins, which, if not removed, provides an ideal medium for drosophila breeding. Similar accumulations, usually small and hidden, may exist in corners, under counters, under baseboards, in the cracks of or around drain boards, in cracks around sinks, etc.

Even soil, contaminated by drain water, may contain enough waste vegetable matter to support drosophila development.

Many of the above illustrations of breeding media apply to homes also. In addition, a common source of infestation in residence is homemade marmalade, preserves, chili sauce, mustard pickles, etc. put up in jars. Wine, vinegar, sauerkraut, "home-brew" and cider are also common attractants.

Animal excrement is less attractive than fermenting fruit, but it provides a suitable breeding medium for drosphila flies. In rural areas, outdoor privies may be the source of a drosophila fly population.

Drosophila flies sometimes breed in trickling filters found in sewage treatment plants. The method of controlling them is to flood the filter bed for 24 hours at intervals of a week or two. This procedure drowns the larvae. Breakdown of control in such a system might be the cause of unusual infestations in the vicinity of treatment plants.

Control

Sanitation is the primary consideration in drosophila fly control. In most homes, restaurants, bars and similar locations, sanitation is essential to the solution of a drosophila problem. Other locations, such as food plants, might require supplemental measures, such as special screening or insecticide treatments, but sanitation should be the basic consideration in any control program.

Canneries, wineries, breweries and similar food-processing plants have the problem that the food products or by-products themselves may be attractive to drosophila.

Tomato-processing plants are particularly susceptible to drosophila invasion.

CLUSTER FLIES

Description and Life History

This species is similar to the housefly but is slightly larger and narrower; the thorax has many short, yellow hairs, and the abdomen is hairy and somewhat iridescent. The female deposits eggs in cracks and crevices in the soil. Incubation requires about 3 days. Maggots enter the bodies of certain species of earthworms, where they feed for 13 to 22 days before transforming to the pupal stage, which lasts 11 to 14 days. The entire life cycle requires 27 to 39 days. During the summer, in the latitude of Washington, D. C., there are four generations.

Habits and Habitat

In warm weather cluster flies may be attracted to flowers and fruit trees. With the approach of winter they enter houses and buildings through cracks and crevices, in their search for protected places in which to hibernate. They settle in clusters, particularly in the corners of unused, darkened rooms, in attics, under clothing in closets, in hats, or behind pictures and furniture. They are inactive most of the winter, but on warm sunny days they may revive enough to fly to windows or buzz about the room.

Economic Importance

Adults do not usually visit food or transmit disease. The larvae are parasitic in earthworms. Their presence in a building is annoying because they may spot or stain curtains or clothing in which they hide.

DOMESTIC FLIES

The common domestic flies are:

The housefly, *Musca domestica*

The blowflies, including

Phaenicia spp. (The commonest is *P. sericata*, a green bottle fly.)

Phormia regina, the black blowfly

Calliphora spp., blue bottle flies

Callitroga macellaria, the secondary screw-worm fly

Pollenia rudis, the cluster fly

The stable fly, *Stomoxys calcitrans* (also known as the dog fly and the biting housefly)

The flesh flies, *Sarcophaga spp.*

The false stable fly, *Muscina stabulans*

The little housefly and the latrine fly, *Fannia, spp.*

The face fly, *Musca autumnalis*.

Houseflies

Description: Adult houseflies are familiar to everyone. They may be distinguished from other common flies because they have all of the following characteristics: sponging or nonbiting mouth parts, dull gray body color, four dark lengthwise stripes on the thorax, abdomen not mottled or shiny and the reddish eyes. Less familiar are the egg, maggot and pupa stages through which all adult or winged houseflies have passed.

Habits and habitat: Houseflies lay their eggs on almost any spoiling or rotting substance. Animal manure, human privies, and spoiling garbage or other foodstuffs are favorite places for egg deposition. The eggs hatch in from 8 to 30 hours into small whitish maggots or larvae. They become full-grown in from 5 to 14 days, by which time they reach a length of one-half inch.

When mature, larvae try to leave the filth on which they have been feeding and find a drier place in which to pupate. If dry loose soil is nearby, as around a garbage can in an alley, they will tunnel a short way into the soil.

The pupae are about the size of a grain of wheat but rounded on both ends and mahagony brown in color. After 3 to 10 days, an adult fly will come out of the pupal case, and in 3 to 4 days, females will be ready to lay more eggs.

COMPARISON OF HOUSEFLY AND BLOWFLY

	Housefly *Musca domestica*	Green Bottle Fly *Phaenicia sericata*
Larval rearing medium	Excrement, garbage or any warm, moist, decaying organic matter	Decomposing flesh or animal matter, excrement or garbage
Pupation	In the drier part of the larval rearing medium, beneath debris and occasionally in the upper surface of the soil.	In soil to a depth of 1-1/2 inches to 2 feet.
Flight range	Usually limited to the area in the immediate vicinity of the breeding media, but may fly 2 to 20 miles under certain conditions.	Disperses widely in search of food and breeding media, commonly 3 to 4 miles, sometimes farther than 10 miles.
Adult nighttime resting habits	In buildings, on ceilings and overhead structures. Outdoors on grasses, weeds, trees, shrubs and clotheslines.	Outdoors in grasses and weeds.
Adult daytime resting habits	Rests on foods, walls and furnishings. Outdoors on the ground, on garbage, around porches, and to some extent on vegetation.	Usually outdoors on the ground, on garbage, and on grasses and weeds. Enters house in spring and fall. Tends to alight on foods rather than walls and ceilings.

Sanitation: Sanitation presents the most fundamental approach to fly control. In many locations, it may be the only satisfactory solution to a fly control problem. In others, it may be economically infeasible to practice sanitation to the point of effective fly control. Most situations are between these extremes. In general, sanitation is not being utilized in our fly control operations to the optimum extent.

Sanitation in fly control consists of cleaning up or covering up the various media which are suitable for the development of fly larvae or which are attractive to adult flies. Optimum use of sanitation in fly control requires the recognition of fly breeding media. In the city, garbage is probably the major source of the fly population. A survey in Savannah, Georgia, revealed that the city garbage dump was the most important single source of flies and the individual garbage cans were the second principal source. Sixty percent of all garbage containers in the city were found to be actively producing flies in "garbage sludge" in the cans or in the soil immediately underneath. In residential areas, dog feces ranked next. Other important sources of fly production were privies, abattoirs (slaughter houses), poultry houses and stables. A rather unexpected observation was that certain areas highly attractive to flies, such as grocery stores, feed stores and dairy plants, were not supporting significant fly breeding except in their garbage areas.

Scudder, reporting on sanitation in relation to fly control, pointed out several media commonly overlooked as sources of fly breeding. On dairy farms, a high-protein stock food, spilled and permitted to become moist, may be the major source of the fly population rather than the manure pile. Temporary manure piles on the ground or residues in manure spreaders (or garbage trucks) may be serious sources of flies. Cattle urine pits in earthen floors with but little manure in them have proved to be a heavy source of flies. Of course, the manure piles from the various domestic animals may be serious sources of breeding. The most direct control in these is to spread the manure in the fields regularly and frequently enough to prevent development of fly populations. In some areas, this may have to be done oftener than twice a week.

Around restaurants, the problem may be quite dependent upon the degree of sanitation that can be practicably achieved in the surrounding area, but sources of breeding very close to or within the restaurant often are overlooked. Fly breeding may come from garbage area even though the cans are washed clean every day. If liquid foods or wash water containing food are allowed to seep into soil, even though the soil may be under a platform, between bricks or under a gravel cover, fly breeding may be heavy in this soil. Scudder has drawn attention to scraps under a loading platform as a source of fly breeding. Other sources are: scrapings and grease accumulations around stoves; sludge accumulations in corners and in drains; scraps and mopping residues that may collect under counters, tables, refrigerators or shelf bases; accumulations in the pits of dumb-waiters; and even dirty dishes, unrinsed cans or soiled linen.

In certain areas, industrial waste may be a serious source of fly breeding. Control in such locations is essentially a magnified garbage handling problem and, again, saturation of the soil with waste should not be overlooked as a factor which may provide an adequate fly breeding medium. This saturation may occur in soil under gravel or blacktopped parking areas.

Minimizing attractant odors may be an important result of sanitation. Maintenance of a clean garbage can, properly covered, may be of more value in fly control through its failure to attract flies than through elimination of breeding media. Keeping driveways, yards, platforms, and floors free from materials attractive to flies may lessen the problem greatly. Don't permit a premise to be any more attractive to flies than the operation in it absolutely requires.

Don't overlook the importance of moisture in fly breeding media. Often provisions of simple drainage will aid control.

Although it may not always be possible or economically feasible to practice all the sanitary measures that would contribute to fly control, very frequently simple sanitation will make the difference between satisfactory and unsatisfactory fly control. Sometimes, striking results can be obtained through sanitation alone. It is important that the pest control operator be able to recognize potential fly breeding media and that these be eliminated as sources of populations to the extent possible.

Any sanitation program in fly control must be tailored to fit each specific situation. Basically, it should include any step that will help to eliminate or prevent the establishment of any medium in which fly larvae will develop or which will be attractive to adult flies. The following procedures are typical of those that will help if they can be effected:

1. Garbage disposal. Use standard 20-gallon metal garbage cans with tight lids. Drain and wrap garbage. Keep lids on the cans. Keep the cans clean. An aid in keeping them in good condition and clean is to paint the bottom and seam edge inside and the top band edge with a paint such as red lead. Wash the cans regularly and do not permit the washings to soak away in soil. Collect the garbage at least twice weekly. Dispose of it in a sanitary landfill or by incineration, not on a dump. Keep disposal equipment clean. When garbage or other potential breeding media is placed in a sanitary landfill, it should be covered with at least 6 inches of compacted soil. A thin layer of loose soil will prevent adult flies from depositing eggs on the media. If the media is infested before being covered, adult flies will emerge unless the soil is compacted on top. They can do so through more than 60 inches of loose soil.

2. Animal excrement disposal. Clean regularly and dispose of the wastes at least twice weekly in such a way as to minimize fly breeding. Keep disposal equipment clean.

3. Clean up and prevent re-establishment of accumulations or organic matter such as waste foods or feeds, moppings and drain accumulations, residues under equipment or storage platforms indoors, or industrial wastes or residues or organic matter in yards, alleys, garbage areas or under loading platforms.

4. Do not permit organic residues to remain in empty containers or soiled linen or other fabrics.

5. Drain areas where waste organic materials may accumulate.

Screening and Prevention of Fly Entry

The practice of screening for relief from flies has been practiced for so many years that little specific comment is necessary. As the residual

insecticides have become less effective, it has become increasingly necessary to obtain as full protection as possible from screens. Surveys have shown that screens are 97 percent effective in preventing fly entry into homes. Screens of 10 mesh (10 openings per linear inch) are satisfactory as fly barriers. Eighteen mesh screening is required to exclude mosquitoes, but this reduces the amount of light and air which can pass through by 36 percent (10 mesh reduces it 20 percent). All entrance doors, windows and other ventilation ports should be equipped with tight fitting screens. Screen doors should open outward. In bad situations, a double set of doors to form a vestibule may be of value It is usually unecessary to screen above the third story of a building.

Doors which must open for customers, trucks or passage of commodities may permit entry for flies. Where such doors are open constantly, an airstream may be used to prevent fly entry.

An airstream that is effective as an insect barrier must have a velocity of 1,600 ft./min. or more. Equipment must be designed for each individual installation. PCO's are not likely to have the necessary engineering skills to develop adequate installation. PCO's may serve as agents for firms producing such equipment.

FLEAS

General Remarks

Customers who call you about fleas will see small dark insects that jump. They may be biting the customer and there is usually a dog or cat living in the house. Customers most often call you about fleas upon returning from vacation. Customers who are being "bitten" but don't see any jumping insects or have any pets probably don't have fleas and you should suspect some other cause of the "bites."

You seldom need to identify the species of flea to control it. Both the infested animal and the premises should be treated for best control. The animal should be treated by a veterinarian or by the owner, not by you.

Description and Life History

Adult fleas are wingless, red-brown to brown or black insects. They range from one sixteenth to one-eighth inch in length and are flattened from side to side. You don't need to know what species you are dealing with if the host animal is evident.

The four states of development of fleas are: egg, larva, pupa, and adult. The time for completion of the life cycle from egg to egg varies with species, temperature, humidity, and food. Under favorable conditions, a generation can be completed in as little as two weeks. It can be as long as eight months.

Eggs are usually dropped while the female is on the host. They are smooth, oval, light colored and large enough to be seen with the naked eye. They fall to the ground or into the nest or bedding of the host since they are not attached to the host. The female may lay several hundred in her liftetime. Eggs hatch in two days to two weeks.

Larvae of fleas are slender, straw-colored, active wormlike creatures. They are blind, avoid light and have chewing mouth parts. Their food is the organic debris usually found in the bed of the host. The feces of the adult fleas are composed of more or less digested blood and are an important part of the larval diet. The three larval instars are completed in from one week to several months.

Pupae of fleas are hard to find as pupation occurs in a cocoon which is covered with organic debris. The pupal stage lasts from five days to more than one month.

The adults may remain in the pupal chamber for extended periods of time. They seem to be released when a host is near, possibly because of vibrations or sensitivity to the body heat of a host. Adults can resist starvation for extended periods both before and after feeding. With occasional feedings adults of some species may survive for more than a year. When not feeding or searching for food, fleas hide in cracks, coarse fabrics or debris.

There are several kinds of fleas that attack both animals and people in this country. The dog flea and the cat flea attack either cats or dogs, and they both bite man. The cat flea is much more common and feeds on a much wider range of hosts than does the dog flea. The human flea, a serious pest in the Mississippi River valley and the Southwest, uses many animals as hosts, although hogs are infested more often than other animals. The sticktight flea is primarily a pest of poultry, but may occur on humans and pets. There are a great many species of rat fleas which are principally pests of rats and other rodents but may also bite man.

Feeding

The food of adult fleas is blood. Without it, females do not produce eggs. Fleas may feed several times a day when hosts are conveniently near, but they can survive for weeks before a meal or between meals. Some fleas bite often, taking frequent small meals. Others, which seem to feed until disturbed, do not stop feeding when full, but continue to pump blood from their hosts and pass it out almost unaltered.

Problems Caused by Fleas

Humans are bothered most by fleas which cannot find their usual hosts. Dog and cat fleas in homes become starved when pets are kept outside during warm weather or are boarded out during vacations. The same problem arises when pets die, are sold or are moved. Rock fleas seek other hosts as soon as a rat dies. At such times, humans are bitten much more severely than when the usual flea hosts are available for frequent feedings.

How the problem develops: Organic debris found in the bedding or nests of animals provides food and shelter for flea larvae. The adults take blood from an animal (the host). Flea populations will build up if an animal and debris are present. The adults usually remain on the host. When the host animal is removed, the larvae and pupae left behind develop and the resulting adults find an alternate host. This alternate is often man. Fleas may also bite man when the normal host is present if the fleas become too numerous.

Effect of flea bites: The typical reaction in humans to flea bites is the formation of a small, hard, red, slightly raised, itching spot. Bleeding usually occurs. The single puncture point caused by the flea's mouth parts is generally apparent in the center of each spot. These characteristics distinguish flea bites and stings of most other arthropods. Ants and spiders leave two marks when they bite. Mosquitoes, bees, wasps, and bedbugs leave a large swelling or welt.

The majority of people bitten by fleas will have a reaction about as described above. A few people have a severe reaction resulting in a general rash or inflammation. Others show no reaction whatsoever. This failure to react may be natural or it may be acquired only after one has been bitten repeatedly for several weeks or months.

Diseases transmitted by fleas: The irritation and the occasional infections from scratching flea bites are the worst effects now experienced by most residents of the United States. There are some important diseases, however, that fleas can transmit. Wild rodents in the western part of this country are plague reservoirs. Plague is transmitted from rodent to rodent and from rodent to man by fleas. The Oriental rat flea can also transmit murine typhus (endemic typhus) fever among rats and from rats to man.

Control

The steps for controlling fleas are as follows;

1. Have old bedding of pets destroyed or washed thorughly. Have floors, carpeting, upholstered furniture, etc. vacuumed if possible if the host is or was indoors. Carefully and promptly dispose of vacuumed materials. Animal manure and debris should be removed from pens and yards.
2. Have the host treated or eliminated. If the host is a domestic animal, the animal should be treated but you should never treat the animal.

Recommend that the pet be treated by a veterinarian or the owner.

SELF-HELP QUESTIONS ON INSECTS PESTS IN BUILDINGS

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. List the identifiable characteristics of silverfish young and adults:

2. In the home, where are silverfish found and what is their food supply?

3. Why are new buildings especially favorable for silverfish population buildup?

4. Describe the temperature preferences of firebrats compared to the common silverfish.

5. Which species of silverfish may be found outside the home in plant mulches?

6. Explain the life stages of a cockroach and the signs left by these stages indicating infestations:

7. How are roaches implicated in disease spread? Directly or indirectly?

8. How does the female German cockroach deposit her eggs?

9. In which areas of the house would German roaches be expected most numerous?

10. How do brown banded roaches differ from the German species regarding egg capsule deposition and feeding areas of the home?

11. Describe the appearance of the American roach and its egg capsule deposition [illegible]:

12. How may American roaches spread and where would their buildup be the greatest?

13. Do oriental cockroaches spread by flying?

14. Describe the egg laying and overwintering habits of the field cricket compared to the house cricket?

15. What damage can be caused by crickets feeding indoors and out?

16. What one characteristic can be used to identify an earwig from a cricket?

17. Are earwigs primarily nocturnal and what is their primary food supply?

18. List four insect pests more commonly causing nuisance problems around the house compared to direct damage or as a disease vector:

19. A boxelder bug must have what host plant present to build up to large numbers? Also explain controls recommended for this pest:

20. Describe the one identifiable character of bedbugs which allow them to live practically unnoticed:

21. What is the food supply of bedbugs and how long can life be sustained without feeding?

22. Do batbugs and swallow bugs feed on man?

23. Will book lice be most numerous in old or new buildings, and what is their food supply?

24. When human lice are discovered infesting a customer's premises, what action should the PCO take?

25. Can proper lighting be used to repell ground bettle infestations? Explain.

26. What controls are suggested for elm leaf beetle control?

27. Name two plant feeding weevils who commonly may invade the home:

28. List for each of the following their full life cycle, their feeding habits and their affect on man and his environment:

    a. ants

    b. wasps

    c. honey bee

    d. carpenter bee

29. Describe physical actions that can be taken to reduce mosquito populations:

30. When moth flies are found in private residences, what control methods should be followed?

31. Explain the life cycle of Drosophila flies and where each stage may be found:

32. Will rotted fruit attract Drosophila? What are some primary attractant materials?

33. Name the primary control consideration used for Drosophila fly control:

34. The larval stage of the cluster fly is spent primarily in the body of what host?

35. What are the adult body characteristics of the housefly?

36. List four factors to consider when establishing a good sanitation program for housefly control:

37. What stages are present in the life cycle of the flea and what affects its full development?

38. Explain the feeding habits of adult fleas:

39. List the three steps required for proper flea control:

INSECTS OF STORED PRODUCTS AND FURNISHINGS

SAW-TOOTHED AND MERCHANT GRAIN BEETLES

The saw-toothed grain beetle, a common pest of many stored food products, is likely to be found any place food is found. The merchant grain beetle has a similar appearance and habits, but prefers warmer climates.

Description

The egg, larva and pupa of both species are the same in appearance; the adults differ slightly.

The miscroscopic egg is white and elongated. Eggs are laid singly or in small clusters.

A full grown larva is less than one-eighth inch long. The dirty white background contrasts with the yellowish plates on the back. There are no pointed projects on the end of the body and, unlike a moth larva, it has no pro-legs (legs on the abdominal segments). The larva is active and can move with good speed.

The pupal case is a capsule of glued foodstuff fragments. The prominent projects on the thorax will become the "saw teeth" of the adult.

The adult beetles are brown, flattened, and slightly less than one-eighth long. Six projections like saw-teeth on each side of the thorax (between the head and the wing covers) are characteristic of both species. You can see these "teeth" easily with a hand lens.

Both species lay eggs in the food material and complete their life cycle there. The adults, which never fly, live 6 to 10 months. The most rapid development occurs at temperatures of about 90°F.

Life History

Saw-toothed grain beetles lay an average of 375 eggs beginning about five days after emergence and continuing for three or four weeks. The eggs hatch in three to five days, the larvae mature in two weeks, and the pupal stage lasts for a week. An entire life cycle can be completed within a month.

Development stops at temperature about 100°F. or below 68°F. All stages die within an hour at 125°F; within a week at freezing temperatures, or within

a week at freezing temperatures, or within a day at 0°F. Relative humidity has little effect on survival or development.

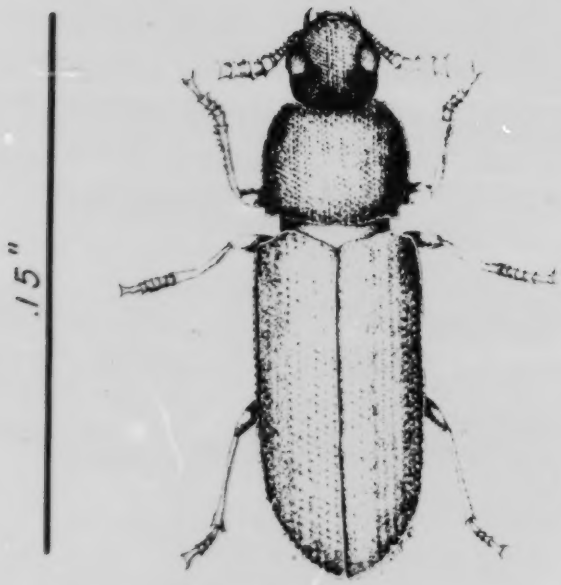
Merchant grain beetles lay an average of only 200 eggs over four to six weeks. At least five weeks are required tor a complete life cycle. All stages are killed within an hour at 125°F or within four days at 37°F. Relative humidities below 30 percent usually stop development.

Food Materials Infested

Both beetles feed on a wide variety of food products. The saw-toothed grain beetle has been recorded from: grains and grain products—alfalfa seed, barley, breakfast cereals, cereal rat baits, corn, corn beads in jeweiry, cornmeal, corn starch, flour, macaroni, milo, mixed feeds, oats, popcorn used as a packaging material, rice, shuffleboard wax, and powdered hand soap containing cornmeal, wheat and wheat bran; spices and herbs; nutmeats; dried fruits; miscellaneous—baking soda, bird seed, candy, chocolate, dietetic food concentrates, dried dog food, drugs, dry carpet cleaners, garbanzos, graham crackers, hay, peas, safflower seed, snuff, sugar, tobacco, vetch seed, and food crumbs in furniture.

The merchant grain beetle probably infests many of the above materials. Many of these records may, in fact, be based on the merchant grain bettle because of confusion in identification. The merchant grain beetle has specifically been recorded from: cocoa, copra meal, cottonseed, dog food, dried figs, grain and grain products, nutmeats, oilseed cake, palm products, raisins, safflower meal, and spices.

CONFUSED AND RED FLOUR BEETLES



PCO's often encounter either the confused flour beetle, or the red flour beetle in food products. The red flour beetle, which flies well, is more common in farm grain storage. The confused flour beetle does not fly. The appearance and habits of both are similar.

Description

The egg is white and microscopic. Food particles adhere to a stick substance on the surface making detection difficult even with a microscope.

The larva is cream to yellow, slender and wiry and reaches a size of three-sixteenth inch. There is a pair of pointed projections at the rear end.

The pupa is white to light brown but is not encased in a cocoon of silk or a cell of food particles.

The adults of both species are shiny reddish-brown, flattened, and about one-eighth inch long.

Life History

The female lays several eggs daily during the first three months. The adults may live for a year or more, are very active, and run quickly for cover when disturbed. They can work their way through imperfect seals into almost any container because of their shape and small size.

Flour beetles may be found on the surface or deep within the food material. In fact, they may complete several life cycles without being noticed until the material is used and the infestation uncovered.

Food Materials Infested

Flour beetles cannot breed in clean, undamaged grain, but they can feed on whole wheat kernels with a moisture content above 12 percent. They breed readily in flour, damaged grain, grain dust, and related products. The insect is usually transported in infested flour. Large populations can develop in flour, crumbs, or other food accumulations in cracks and crevices and in voids or hollow metal cabinet doors. TV viewing rooms are often accompanied by "snacking" and the crumbs left behind in furniture can become infested.

These beetle species have been recorded from: grain and grain products—breakfast cereals, corn, cornmeal, flour, millet, milo, mixed feeds, oats, rice, rye, wheat, and wheat bran; nutmeats; dried fruits; miscellaneous—alfalfa seed, beans, beet pulp, chocolate, copra meal, cotton gin trash, cotton seed, cotton seed hulls, cotton seed meal, flax seed, peas, powdered milk, safflower seed and meal, sunflower seed, vetch seed and spices.

DRUGSTORE AND CIGARETTE BEETLES

The drugstore beetle is found throughout the United States. It will infest almost every known plant or animal products. It is found in homes as well as commercial establishments.

The cigarette beetle is found throughout the United States. It commonly breeds in tobacco, but because it infests a variety of dried plant products, the cigarette beetle is often found in food handling establishments and in homes. It is similar to the drugstore beetle.

Description

The egg is pearly white and microscopic in size. It cannot be easily seen with the naked eye.

The full grown larva of the drugstore beetle is C-shaped (grublike) and about three sixteenth of an inch long. It is creamy white with a brown head and legs. Although it has fine hairs, it does not have the fuzzy appearance of the larva of the cigarette beetle, which is similar but covered with long yellowish brown hairs.

The pupa is concealed within a cell composed of cemented food particles. These cells, or parts of them, can be found in infested food products.

The adult cigarette beetle is a yellowish to reddish brown and about one-tenth inch long. The head is bent downward so that the beetle has a distinct "hump-backed" appearance. This appearance will distinguish it from other pantry pests. The female deposits the eggs in crevices in the food material. There are normally three or four generations a year although an entire life cycle can be completed in slightly more than a month's time.

The adult drugstore beetle is reddish-brown and about one-tenth inch long. It resembles the cigarette beetle but does not have the hump-backed appearance. The drugstore beetle develops more slowly and does not feed in the adult stage. Normally there are only two or three generations each year.

Food Materials Infested

The drugstore beetle is likely to be found infesting any plant or animal products. Sources they have been recorded from are: drugs—laxative teas, strychnine, belladonna, and aconite; nuts—almonds, peanuts, and "hippie beads"; spices and herbs—paprika and red pepper; grain and grain products—alfalfa meal, barley, copra meal, cornmeal, flour, milo, mixed feeds, wheat, wheat bran, and wheat germ; other foods—dry dog food, bread, beans, coffee beans, fish meal, garbanzos, spaghetti, instant chocolate, and powdered milk; miscellaneous—books, and manuscripts, dried flowers, beet seeds, cottonseed meal, cucumber seed, mustard seed, leather, and some fillers and fabric coverings of furniture.

The cigarette beetle commonly infests dried tobacco and tobacco products but it has a wide range of food sources. It has been recorded from: dried fruits—raisins, figs and dates; spices and herbs—ginger, pepper, nutmeg, chili powder, curry powder, cayenne pepper, paprika, tumeric, and saffron; drugs—opimum and belladonna; grains and grain products—alfalfa seed, barley, cornmeal, flour, lettuce seed, milo, mixed feed, safflower meal, soybean meal, sunflower meal, wheat, wheat bran, and rice meal; other foods—beans, cereals, copra, copra meal, fish meal, hay, and peanuts; miscellaneous—pyrethrum powder, dry yeast, licorice roots, dried flowers, leather, woolen cloth, bamboo.

Cigarette beetles have damaged the leaves and bindings of books while feeding on the paste. They have also damaged overstuffed furniture when infesting the hair, straw and other stuffing material.

GRANARY AND RICE WEEVILS

The two weevils of primary importance that attack stored grain in the United States are the granary weevil and the rice weevil. As they generally attack only whole grains, you will seldom find them in residences. They are most commonly found in grain storage facilities or processing plants utilizing whole grains. Both species are similar in appearance but different in biology.

Description

The egg, larva and pupa are in grain kernels, so are rarely seen. The white larva is legless, hump-backed, and has a small tan head. The pupa has a spout like the adult.

The adults are one-eighth inch long and shiny red-brown to almost black. They have a snout common to all weevils. You can distinguish the two species as follows:

Granary Weevil	Rice Weevil
1. Uniform color	1. Four red-gold spots on wing covers.
2. Large, oval pits on pronotum (are between head and wing covers)	2. Small, round pits on pronotum.
3. Hind wings poorly developed; can't fly.	3. Hind wings developed, can fly.

Signs of Grain Damage

The emerging adults cut exit holes in the grain. The granary weevil makes holes larger than does the rice weevil and the holes tend to be ragged rather than smooth and round.

Life History

The female drills a tiny hole in a kernel of grain, deposits an egg in the cavity, and then plugs the hole with a gelatinous secretion. This "egg plug" is difficult to find, even with a microscope. The young larva bores toward the center of the kernel, feeds, grows, and eventually pupates there. If the kernel is inadequate, the larva dies there instead of leaving the kernel. New adults bore emergence holes in the kernel from the inside and leave to mate and start a new generation.

Granary weevil: Females lay about 250 eggs. At 81°F. to 86°F. the egg hatches in three days, the larva matures in 18 days, and the pupal stage lasts for six days. A complete life cycle can occur in four weeks. Only one larva develops in a grain of wheat. The adult lives for seven or eight months.

Very few eggs are laid below 60°F. but the weevil can survive two months or more of 35°F. Death occurs in one hour at 120°F. and in one-half hour at 130°F.

Rice weevil: The female lays 300-400 eggs. Development is only slightly slower than the granary weevil; a life cycle requires at least 32 days for completion. The larvae can develop in one wheat kernel, one on either side of the center divider. These larvae do not penetrate the divider as do granary weevil larvae. Rice weevil adults live four to five months. Unlike the granary weevil, rice weevils do fly. In the south they may fly into the field and infest standing grain. These infestations grow rapidly after the grain is harvested and stored.

The rice weevil develops most rapidly at 81°F. to 86°F., but it cannot withstand cold. It is dormant below 45°F. and two weeks of freezing temperatures usually eliminate an infestation. It is as susceptible to heat as is the granary weevil.

Food Materials Infested

These weevils infest and breed almost solely in whole kernels of grain such as oats, wheat, rye and barley. They occasionally infest beans and nuts. Rarely have they infested caked or compressed flour products such as macaroni and spaghetti. The adults can feed on flour but cannot reproduce in it.

MEALWORMS

You will usually find mealworms (adults and larvae) in dark damp places in spoiled grain products. In residences, you will most often see them in basements or at grade level. The adults are easily confused with ground beetles in appearance. The dark mealworm is found throughout the country; the yellow mealworm is more common in the north. Both species are similar in appearance and biology. Control of both is the same. Mealworms are raised in large numbers by some people for use as fish bait or as food for birds and other pets.

Description

The description below applies to both species except where noted.

The eggs are white, bean-shaped, and about one-twentieth of an inch long. The young larvae are white but darken with age. They have a highly polished

appearance and grow to a length of one and one-fourth inches. The yellow meal worm is honey-yellow and the dark meal worm is yellow-brown.

The pupae are white at first and then turn yellow. They are not enclosed in a case or cocoon.

The beetles are robust, black and slightly more than one-half inch. The yellow meal worm adult is shiny black; the dark meal worm adult is dull black. The adults greatly resemble many ground beetles in size, shape and color; but it's important to distinguish them from ground beetles.

Distinguishing Mealworms from Ground Beetles

If many larvae are present, they are probably mealworms, as ground beetle larvae—if seen at all—are usually lone individuals. Ground beetle larvae are not highly polished in appearance.

If only the adult is found, examine the hind leg with a good hand lens or a microscope. Ground beetles have five tarsal segments. Meal worm adults have only four tarsal segments on the hind leg. Meal worm adults do not move as rapidly as ground beetles.

Life Cycle

The eggs are laid singly or in small clusters in the breeding media in the spring. They hatch in four days to two weeks. The larvae usually mature by fall but don't pupate until spring. Development stops at freezing temperatures.

Two years may be spent in the larval stage under adverse conditions. The mature larvae usually come to the surface of the food to pupate and may wander some distance from the food material. They occasionally burrow into soft, rotting wood to pupate. The pupal state lasts from 7 to 24 days.

The adults hide in dark places and are most active at night. They are strong fliers, however, and attracted to lights. They usually live for two or three months.

Materials Infested

Mealworms are primarily scavengers and prefer to feed on decaying grain or milled cereals that are damp and in poor condition. They have been reported as feeding on cake mixes, corn cobs, cornmeal, cornstarch, all grains, mixed feeds, cereal rat baits, potatoes, bran, flour, oatmeal, bread, crackers,

dried soups, meat scraps, feathers, dead insects, and litter from chicken houses. Chicken litter is sometimes used to fertilize lawns and, if infested, can lead to large numbers of mature larvae migrating indoors. They have also been found living under old carpeting in a damp area.

DERMESTID BEETLES (HIDE, LARDER, INCINERATOR)

Description

All of these beetles are dark colored, typical oval dermestid shape, and between three-sixteenths and three-eighths inch in length. The full-grown larvae are longer than the beetles, often attaining a length of one-half inch. The larvae are slender, densely covered with long or short hairs, and each bearing a pair of distinct spines on its dorsal side near the tail end. The direction in which these spines point often determines the species. Larval color is usually a dark to reddish-brown.

Life History

The development period of the four beetles described here can vary considerably with different food, temperature, and humidity conditions. One can generally expect development from egg laying to adult to be one to three months. Under adverse conditions, however, this period may last several years. Adult beetles may live two to three months, and some have been recorded living as long as a year.

Habits and Habitat

The larder and hide beetles are world-wide in distribution where they occur both in buildings and outdoors. Adults apparently require a high protein diet prior to oviposition. Eggs are laid on or near food suitable for the larvae. After hatching, the larvae will seek food, and if what they find fulfills their development needs, they may remain on it throughout their growing period. A dark environment is preferred.

Foods are numerous, and places of infestation varied. The larvae and adults will feed on almost any animal substance which is dry or in the process of

decomposition. They will also occasionally feed on dry vegetable material, although animal matter is necessary for completion of development. In homes and storage areas they infest cured meats, cheese, dog food, fish, hair, hides (including fur pieces), stuffed animals, and even fertilizers that may contain substantial amounts of animal by-products. Damage to wool as such is rare. Although the insects are often found in raw wool storage warehouses, it is believed they feed primarily as scavengers on dead insects of other species.

In commercial establishments, larder beetle larvae may be found in stuffed animals, horns, hoofs, bones, hides, hair, fish meal, yeast, and spoiled potatoes. Accumulations in partitions, cracks, and other obscure places make such objects as kitchen ranges, meat blocks, butcher wrapping counters and food machinery possible harborages for larvae. Dead insects, such as bees in walls, and abundant grain and stored food product pests may be sufficient for development of this group of beetles, and carcasses of rats, mice, squirrels, bats, and birds may become infested. Dead animals in partitions or chimneys are frequent sources of these beetles in homes.

At the completion of larval development, the larvae usually leave their food and migrate to some protected place to pupate. This migration may extend over a considerable area and, if suitable cracks are not found, the larvae will burrow into material to make protected cells for pupation. The pupae, therefore, are often found in materials which are not food. Damage of this sort includes wood, cork, lead, mortar, books, woolens, tobacco, and even underground telephone cables. Larvae have been reported cutting through lead and tin, but steel and aluminum appear to be impervious. Normally, such borings are little longer than the larvae, but occasionally they may extend as deep as 10-12 inches. Severe cases have been recorded where structural timbers have been weakened by numerous borings.

Control

The migrational tendencies of these beetles make the locating of the actual infestation difficult, and sometimes complicate the control picture. Often the larvae go quite some distance, so that they and the pupae may be well scattered throughout a home or other building. The adult beetles may be present even after an incinerator is cleaned out or other source of infestation is eliminated. It is sometimes hard to tell where they are, so that control is

sometimes a matter of guesswork and stragglers may continue to emerge for weeks thereafter. It is also frequently noted that larvae in all stages may leave food materials and seek crevices at times when they are not actively feeding.

Dermestes larvae are sometimes considered beneficial since they are good scavengers and are even used to clean the flesh off animal skeletons for the preparation of museum specimens.

TROGODERMA (CABINET BEETLE)

Description and Life History

The cabinet beetles are similar in general appearance to the carpet beetles, and must be examined carefully to avoid misidentification. The adults are small and oval, ranging from one-tenth to three sixteenths inch in length. The base color is black to brown with very indistinct markings on the dorsal surface as follows: pronotum often with prominent reddish-brown markings; wing covers with irregular reddish bands and spots; dorsal hairs pale or white, the latter usually forming patches on both the pronotum and wing covers. The larvae resemble those of immature carpet beetles and are yellowish-brown in color. The lateral hairs are not formed as long tufts, however, but as sparse, individual hairs of different lengths.

Development time from egg to adult emergency usually is from two to five months, but inadequate food supplies may greatly lengthen this period. The fact that the larvae molt 8-12 times results in the accumulation of many cast skins on the surface of the food. The number of molts may also increase with inadequate diet resulting in increasingly smaller larvae until death occurs or food is found.

Habits and Habitat

As is typical of dermestids, the larvae shun light but the adults may be attracted to it after oviposition. The adults do not feed. Foods of the cabinet beetle larvae are various and include prepared food mixes, flour, cereals, dog food, nuts, dried fruit, tobacco, and occasionally grains. They have even been found in vitamin capsules. The larvae are well-known pests of insect

collections, being more distinctive even than the varied carpet beetle in most of this country. Outdoors, these dermestids are scavengers in the nests of bees and wasps. Their presence in mud dauber nests in attics of homes is a constant source of infestation for the rest of the house.

Economic Importance

Although cabinet beetles are broadly considered as minor pests, they often occur in specific localities in such numbers as to constitute severe infestations. Such infestations may be as extensive as an entire shipment of prepared foods, or as limited as a bag of flour in a home. With respect to woolens and furs, cabinet beetles are minor pests. In the United States, these insects are most prevalent east of the Rocky Mountains.

BLACK CARPET BEETLE

The black carpet beetle is generally recognized as the most destructive of the carpet beetles and may be the most destructive single pest of woolen fabrics in this country. It is a cosmopolitan insect. It may have originated in the Orient, but it has been established in this country for at least 150 years. Much of the knowledge of the biology and habits of this pest have been gained in commercial laboratories, where it is widely used as a test insect. The black carpet beetle feeds on both animal and plant products. In addition to wool and many materials, it also damages hair, fur, feathers, horn, dried meat, dead insects, kid leather, milk powders and book bindings. The larvae are capable of entering food and other containers which are not perfectly sealed. The searching habit of the larvae often results in their presence in packages of nonfood products.

Their place in nature is that of a scavenger, especially of materials having a high protein content. Thus, when they occur in cereal products, it is usually because that food has been previously infested with other insects. The dead bodies of the primary pest provide the diet preferred by the black carpet beetle larvae. For the same reason, they frequently occur on the grain dust which

accumulates on beams and equipment in mills and other food processing plants. In homes, as well as in commercial buildings, infestations often develop after the beetles have naturally infested such materials as wasps nests in attics, abandoned bees nests in walls, rodent bodies in walls, animal nests or birds nests in chimneys, eaves or attached bird houses. Larvae started in such locations readily migrate into the living quarters of the building. There they find and are able to thrive on lint and dust within, under, between or behind furniture, appliances such as radios and record players, rugs, floors, baseboards, enclosed portions of furniture and air ducts. Occasionally such fabrics as silk flower screens, cotton and burlap sacking are damaged, especially when these materials are heavily contaminated with the more usual food materials of the insect.

Life History

Depending upon environmental conditions, such as temperature and humidity and the presence of food, a black carpet beetle larva may pass through from 6 to 20 or even more molts. When the molting time comes, the larva generally crawls to some hidden undisturbed location. After a resting period, the larva molts by splitting the old larva skin longitudinally at the front part of the back. The larva emerges through the slit and crawls away to find another feeding place. This habit of finding a quiet place for molting contributes to the variety of damage caused by this pest, for the food eaten after a molt may be in quite a different area and of entirely different composition than that used before the molt.

The black carpet beetle is a wanderer, a spot feeder, taking a meal here and a meal there. Generally speaking, the searching and feeding is done in sheltered areas. Thus, in homes, black carpet beetle damage is frequently found under furniture, such as under pianos, under heavy furniture and around the edges of carpeting and baseboards. In these areas, there is little traffic. If the food is not good in the sheltered locations, the larvae may move out to a more desirable area for a meal and then return to hiding.

The adults are active insects, relatively strong fliers and are attracted to light. Consequently, they are frequently found about windows.

ANTHRENUS CARPET BEETLES

Descriptions

The three *Anthrenus* carpet beetles—furniture carpet beetle, varied carpet beetle, and carpet beetle—are sufficiently similar in appearance and habits that they can be treated together. The adults are all smaller than those of the black carpet beetle, more nearly round in outline, and all are mottled, varying in color from nearly white to nearly black. The darkest of the three is the carpet beetle. It is dark gray to black, with three irregular cross bands of white scales. A distinctive character is the brick-red stripe down the middle of the back where the two wing covers join. Underneath it is pink to yellow. The varied carpet beetle is generally gray, this being a mixture of white and yellow scales with irregular black cross bands. Its underside is gray to yellow. The furniture carpet beetle is nearly white, but checkered with black spots, each of which are outlined with yellow to orange scales. The underside of this beetle is pure white. The habits of the adults of these three beetles are very similar to those of the black carpet beetle. They are active, fly well and are frequently found at windows.

Habits

The habits of the species are markedly different from those of the black carpet beetle. None of the three species has the tendency to burrow that the black carpet beetle shows so strongly. As a result, they are more frequently found as surface feeders. A heavy infestation often will show large numbers feeding in close proximity to each other over the surface of a fabric but feeding in close proximity to each other over the surface of a fabric but feeding deeply enough to make holes through the fabric. As with the black carpet beetle, they prefer sheltered and darkened areas.

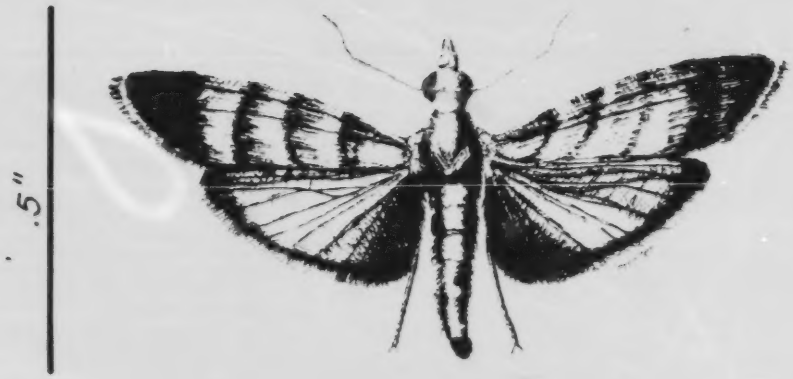
On cereal products of high protein content, the species will survive. The larvae remain on the surface, however, and none of the species appears to propagate well.

The varied carpet beetle is a cosmopolitan insect which has been known in this country for at least 100 years. It commonly feeds on wool, hair and feather products. As a scavenger it frequently infests birds nests and insect collections and has been reported as damaging various horn materials, leather book bindings and crude drug products. As a wool pest in the United States, this insect appears to be more important west of the Rocky Mountains.

The furniture carpet beetle is an introduced pest. Since introduction, it has spread throughout the Mid-Atlantic and North-Central states and appears to be increasing in numbers as well as in distribution. The life cycle of the furniture carpet beetle may be completed in as little as three months, but has taken as long as fourteen months. Under average household conditions, it tends to have either one or two generations per year. If conditions are favorable for development, this insect may increase rapidly, as it can have three to four generations per year.

The carpet beetle known as buffalo bug or the old-fashioned carpet beetle, seemes to be less common than formerly in the eastern part of this country, but it is still important as a fabric pest in the Midwest and far West.

INDIAN MEAL MOTH



The Indian meal moth is the commonest food-infesting moth found in homes in the United States. You can easily distinguish the adult from other "house" moths by the wing markings. It is also common in grocery stores and other food-handling establishments. It is a general feeder and attacks stored grain, milled cereal products, dried fruits, and a variety of other food product.

Description

The microscopic eggs are dirty white. They are laid singly or in clusters on the food, but they do not stick to it.

The larva are about one-half inch long when full grown. They are usually dirty white but sometimes are tinted green or pink. You can tell them from beetle larvae because they have well-developed prolegs (knob-like "feet" on the underside of the abdomen). Beetle larvae have none. The mature larvae which wander may be confused with clothes moth larvae. Indian meal moth larvae have five or six ocelli (eyespots) on each side of the head but clothes moth larvae have none or but one pair.

The light brown pupae are formed within silk cocoons spun by the larvae.

The adults at rest are about three-eighths of an inch long. They have a wing spread of about three-fourths inches. The color of the front pair of wings is the best distinguishing characteristic. The outer two-thirds of the wing is red-brown with a coppery luster, while the inner one-third is silver gray. The head and "shoulders" are red-brown and the hind wings are gray.

Life History and Habits

After emerging from the cocoons, the adults mate and begin laying eggs immediately. The females lay from 39 to 409 each, but 128 eggs per female is average. The eggs hatch in two days to two weeks. The larvae feed in or near a tunnel-like case of silk and grass, but they often travel through the food material spinning a thin silken threat behind them. Food materials may be completely matted with this webbing if the infestation is heavy.

The larvae mature in about five weeks but they may mature in 13 to 288 days. They then spin a cocoon in which to pupate. Before spinning a cocoon, they may wander far from the food source. The pupal stage lasts about two weeks.

An entire life cycle can be completed within four weeks under favorable conditions. There are five or six generations per year in most of the United States. Cold periods are spent in the larval stage which is very resistant to low temperature. The most rapid development occurs at about 82°F.

The adults live only one or two weeks and do not feed. They are chiefly night fliers and become active at dusk. During the day, they prefer to rest on walls, ceilings, boxes, etc. in poorly lighted areas. If disturbed, they fly in an irregular zigzag pattern.

Feeding

The Indian-meal moth larvae prefer corse milled products such as whole wheat flour and cornmeal. All grains and grain products are subject to attack as are nuts, including almonds, peanuts, pecans, and walnuts. Dried fruits such as raisins, figs, prunes, and currants have been infested. Less common sources of infestation are: garden seeds, graham crackers, powdered meat, dried mushrooms, cookies, and beehive products.

ANGOUMOIS GRAIN MOTH

The Angoumois grain moth is an important pest of stored grain throughout the United States. The rare infestation in residences usually comes from decorative ear corn or seed "pictures." It is also rare in mills since it infests only whole kernels of grain.

Description

The adult has a wing spread of about one-half inch. It is about one-fourth inch long when the wings are in a normal resting position. The front wings are yellow or buff-colored. The hind wings are gray with long hairs (fringe) along the edge. The hairs are longer than the wing is wide. A notch gives the end of the hind wing a pointed appearance. This characteristic distinguishes the Angoumois grain moth from others of similar appearance.

Life History

The eggs are laid singly or in small groups on the grain kernels. They hatch in four or five days and the larvae bore into the grain. Entry is difficult on hard, well-dried grain, so infestations are usually found in damp

or freshly harvested grain. The larvae remain in the kernel, develop in about three weeks, and pupate there. The adult emerges 10 to 14 days later.

Development stops below 60°F. or above 95°. The larvae lie dormant in the grain during winter but the adults cannot survive cold. Eggs fail to hatch after a week of 32°F.

The adults are strong but erratic fliers. They are often seen resting on the infested material. They lay eggs on stored grain or fly to the fields and infest ripening grain.

Material Infested

The Angoumois grain moth attacks, for the most part, only whole kernels of corn, wheat and other grains and seeds. They are sometimes found in homes emerging from decorative ears of corn or seed "pictures." Bird seed and cereal baits for rats are subject to infestation if they contain whole kernels. Unusual infestations have been reported in cornmeal, flour, cashew nuts, hulled chestnuts and dry minced onions.

WEBBING CLOTHES MOTH

This is the only species of clothes moth which is commonly encountered throughout the United States. It is the most important of the clothes moths and appears to be the most important fabric pest in the Southeast and Southwest. This predominance does not extend to Florida, Georgia or California.

Life History

The webbing clothes moth passes through four stages in its development: egg, larva, pupa and adult. The length of time taken from egg to adult depends upon the temperature and humidity of the environment and on the availability and suitability of food. Where low temperatures, low humidities, or marginal food supplies exist over a major portion of the year, there may be only one generation a year. If the temperature or humidity is more favorable, there may be three or even more generations under home conditions.

Description

The adult webbing clothes moth is yellowish or buff in color. There are no markings on the wings. It has a wing spread of about one-half inch. It is normally seen in the sitting or running position in which its wings are held closely to the sides of the body, sloping over it like the roof of a house.

The adult webbing clothes moth is sometimes confused with the Angoumois grain moth which is of similar color and size. They sometimes can be distinguished by their habits, for the Angoumois grain moth readily flies in daylight while the clothes moth prefers to avoid light, mostly frequently being seen only in darkened corners at night. Another point on which they may be distinguished is the rear wing, which is narrowly pointed at the tip in the Angoumois grain moth, while in the clothes moth it does not have this narrow point.

The freshly hatched larva of the webbing clothes moth cannot exist on the wool alone. When a woolen garment is soiled with such things as soup, gravy, beer or wine, the survival of freshly hatched larvae is nearly 100 percent; while on clean wool it is only about 1 percent. When the larva is full grown it arrives at the prepupal stage, in which stage it frequently travels away from the site of major feeding in search of a place suitable for pupation, usually in a corner or crevice where there is less chance of being disturbed. By the time the larva has reached this stage it has completed most of its feeding and these migrating prepupal forms cause no significant damage to fabrics. In many instances, however, the larva may remain in its feeding tube for pupation.

The adult moth does not feed and does no direct damage to fabrics. The female is responsible in the main, however, for the distribution of the infestation in the home. It is she that seeks out, either consciously or at random, the new potential foods for the larvae and deposits her eggs on them. It is unlikely that the newly hatched larvae move over great distances in search of preferred feeding spots, although laboratory tests have shown them to congregate at a single soiled spot from all corners of an 18-inch square.

The female moth usually does not fly because of the relatively great weight of her egg load. The heavily ladened female travels by running and frequent feeble attempts at flight. This behavior is the basis for their being called "hoppers." Any clothes moth seen fluttering about the house at night is usually a smaller lighter male.

THE CASEBEARING CLOTHES MOTH

The casebearing clothes moth is so named because the larva feeds from within a portable case. This case, constructed of spun silk and fragments of the larval food material, is a slightly flattened, open-ended cylinder, broader in the middle and may bulge at either end. The larva rarely leaves this protection, but crawls with only head and front legs exposed from the case which is dragged along behind. The larva of this species does not spin a webbing of silk over its food material, but rather eats out clean-cut holes. The largest cases are slightly less than half an inch in length. Feeding is normally carried out on the surface of materials, but the larva with its case may be found below the surface in very thick fabrics, or under rugs.

The life cycle of the casebearing clothes moth is similar to that for the webbing clothes moth. Normally, one or two generations are completed in a year, but under favorable conditions, three generations may occur; and under unfavorable conditions, two years is required for a generation. In habits, the chief distinctions between the two species are that the casebearing clothes moth larva grows in a case and feeds in rather restricted locations without covering the food material with webbing. The feeding habits are similar in that the young larva require soiled wool for favorable development.

SELF-HELP QUESTIONS ON INSECTS OF STORED PRODUCTS AND FURNISHINGS

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. List the identifiable characteristics and preferred general types of food describing the following pests:

   a. Saw-tooth grain beetle

   b. Merchant grain beetle

   c. Confused and red flour beetles

   d. Drug store and cigarette beetles

   e. Granary weevil

   f. Rice weevil

   g. Meal worms

h. Larder beetles

i. Trogderma

j. Black carpet beetle

k. Anthrenus carpet beetle

2. Describe the life stages of the Indian meal moth and compare its larval stage to that of a beetle larva?

3. Will the Angoumois grain moth generally infest grain mills? Explain.

4. Explain the differences in the adult stages of the Angourmois grain moth and the webbing clothes moth.

5. Explain the differences in the larval stages of the webbing clothes moth and the casebearing clothes moth?

6. Can cleaning of garments affect clothes moth populations at a later date?

7. Describe the flight characteristics of the male and female webbing clothes moth.

ANTHROPODS OTHER THAN INSECTS

SOWBUGS AND PILLBUGS

Sowbugs, which are also known as woodlice, are found throughout the United States and feed primarily on decaying organic matter although some occasionally damage roots of green plants. They normally live outdoors, but may wander indoors where they do no damage.

Some species can roll themselves into a tight ball and are known as pillbugs or "roly-polies." The general habits, biology, and control of pillbugs and sowbugs are the same.

Description

Sowbugs are oval or slightly elongate and up to one-half inch in length. They are wingless and are brown or grayish (usually slaty-gray) in color; their body segments are easily visible and appear as armored plates. Sowbugs have two short, but prominent tail-like appendages, seven pairs of legs and most species have well-developed eyes. Pillbugs are similar except that they lack the tail-like appendages and can roll up into a tight ball. Both pillbugs and sowbugs are relatively slow-moving creatures which can neither jump nor fly. They are crustaceans (as are shrimp, crabs and lobsters) and not insects.

Life Cycle

Breeding occurs throughout the year, but most sowbugs and pillbugs mate in the spring. The eggs, which number from 7 to more than 200 in a brood, are carried by the female in a brood pouch on the underside of the body. The eggs hatch in three to seven weeks. Once the young leave the brood pouch, they never return. Some species produce only one brood each year, while others produce at least two. Individuals may live for three years. They are inactive during cold weather although they may be found in basements during winter months.

Habits

Sowbugs and pillbugs have high moisture requirements, do not like lights and, except in special cases, are active only at night. During the day they can be found under trash, rocks, boards, under decaying vegetation, such as accumulations of grass clippings or flower bed mulch, or just beneath

the surface of the soil. They also hide in crevices in dark, damp basements. They breathe through gill-like organs on the underside of their bodies. Therefore, adequate moisture is very important for their survival.

Since they require moisture, they will be found in moist places. Some species can survive dry conditions for a few hours or perhaps a day. During extended dry periods, sowbugs will burrow deep into the soil if water is not otherwise available. They often cluster together to conserve moisture.

Feeding

Sowbugs feed principally on decaying organic matter such as flower bed mulches, grass clippings, and leaf litter. Some attack the new roots and tender stems of growing plants and can become nuisances in greenhouses. Actually, sowbugs will feed on any soft, moist vegetable matter and they are often attracted to overripe fruits on the ground.

Sanitation

Removal of hiding places, food materials, and moisture sources are practical sanitary measures which aid chemical control, and will help to prevent future infestations. The removal of piles of leaves, grass clippings, mulch in flower beds, fallen fruit, and dog droppings, eliminates both food and hiding places. Boxes, boards, and other debris should be removed or stored off the ground to eliminate the moist places of shelter which sowbugs and pillbugs require. Basements and subfloor crawl spaces should be properly venilated to eliminate excess moisture.

CENTIPEDES

Centipedes are many-legged nuisance pests which are often confused with insects. They have too many legs to be insects, and belong to the class Chilopoda. Only one species, the house centipede, commonly lives indoors. Most United States species live outdoors. Centipedes do not damage food supplies or household furnishings. Since they eat insects, spiders, etc. they are beneficial, but most people consider them nuisances and want them controlled.

Description

Centipedes are usually brownish, flattened, elongated animals having many body segments with one pair of legs attached to most of the segments (millipedes have two pairs of legs on most segments are are not flattened). They range in length from one to six inches and can run very rapidly. The number of pairs of legs varies from 15 to more than 100, and the antennae are long enough to be easily seen.

The house centipede has 15 pairs of legs which are extremely long, and hold the body off the surface it is resting or walking upon. The antennae and the last pair of legs are each nearly twice the length of the body itself. The somewhat cylindrical body is one to one and one-half inches long, grayish and marked above with three dark stripes running the length of the body. The legs are banded with light and dark rings.

Habits

Centipedes are most active at night and most species have very poorly developed eyes. They are found in damp, dark places such as under stones, fallen leaves, logs, bark, and in crevices of the soil. Indoors, centipedes are most likely to occur in damp basements, damp closets, and in bathrooms or other areas where the humidity is high. During the day they will hide in dark corners, in cracks and crevices, or under objects such as bedding. All of our common centipedes can run rapidly when disturbed and can easily scale walls.

All centipedes have venom glands, but the jaws of the smaller species cannot easily penetrate human skin. Even the large species found in the southern states cannot inject enough poison to be harmful to humans, although their strong jaws may tear the skin.

Food

Centipedes are predacious, feeding mostly on small insects and spiders. Occasionally centipedes will approach lights and capture the insects attracted to light.

MILLIPEDES

Millipedes, or "thousand leggers" as they are commonly known, are not true insects. They are wormlike arthropods with many short legs and belong to the class Diplopoda.

Although millipedes occasionally become pests in homes, apparently they enter structures only by accident. They are scavengers on decaying vegetation and prefer a moist environment. They do not feed upon structures or furnishings within homes, and cannot bite or sting, but crushed millipedes may stain goods. They occur throughout the United States.

Description

Millipedes live on land and breath air. Most species are not much more than an inch in length, but a few may become as much as four inches long. Their bodies are cylindrical or slightly flattened and are composed of many segments. The first segment, the distinct head, is followed by the four segments of the thorax. Each of the remaining segments, making up the abdomen, has two pairs of legs. This last characteristic of millipedes makes it easy to distinguish them from centipedes which have only one pair of legs on each of the body segments and are usually flattened. Millipedes tend to coil up when resting.

Foods and Habits

Millipedes breed in decaying vegetable matter which is also their principal food. Small numbers of millipedes are present in lawns, gardens, and forests and similar moist places. A few such individuals may wander aimlessly into homes or other structures. It is possible for millipedes to breed in planting boxes or large pots, especially if excess mulch is present, but this is not a common occurrence in homes.

Occasionally large numbers of millipedes migrate and find their way in structures. The reasons for the development of great numbers and the migrations of millipedes are not fully understood. Large accumulations of decaying vegetable matter such as leaves, brush, logs or grass, in combination with an amply supply of moisture is favorable for their production. As the number of millipedes increases they will be forced to migrate as the food supply dwindles. Migration may also occur when too much or too little moisture in the breeding area forces millipedes to migrate to more favorable environments. Such migrations

generally seem to occur in an uphill direction, but it is not known whether this is due to some instinct to climb upwards, or merely because the favorite breeding locations are in low places.

The life cycle of millipedes is not well known. Most species overwinter as adults and lay eggs singly or in small groups in or on the soil. Depending upon the species, one female will lay 20 to 300 eggs. The eggs usually hatch within a few weeks and the young pass through seven or eight instars before becoming adults in the fall. Some species also have another type of life cycle, in which late immature stages overwinter with sexual maturity occurring early the next summer.

Sanitation

The removal of food and harborages will generally increase the effectiveness of any chemical treatment and may prevent development of infestations in the future. Compost piles and other accumulations of decaying vegetation should be kept as far away from structures as possible. Trash and leaf litter against the foundation should be removed. If excessive moisture in subfloor crawl spaces appears to be aiding millipede development, measures should be taken to keep such spaces dry. It is not often practical to remove peat moss or other organic mulches from around foundations plantings, but the customer should be made aware that these factors favor the presence and/or development of millipedes.

MITES ATTACKING MAN

For the guidance of our industry, we are listing below the mites that are known to attack or annoy humans with some frequency in the United States

Chicken mite: This mite is the best known of the mites infesting poultry. It is found on the birds only when it is feeding, which is normally at night. In the daytime it hides in cracks and crevices in the vicinity of the roost. The chicken mite will feed freely on many birds other than chickens, including pigeons, canaries, sparrows, swallows, doves and wrens. When the mite attacks man it causes a mild dermatitis and itching. Cases of dermatitis caused by this mite undoubtedly are common in rural areas, but several cases are on record from cities. They include instances where the infestations were traced to pet canaries, pigeons and nests of other wild birds. There are some cases on record of the death of the bird host or its departure from the nest bringing on the attack on man. It is believed that this species can live for several months without food, so positive methods of eradication are required where they are a problem.

Northern fowl mite: This mite is very similar to the chicken mite in appearance but is very different in its habits in that it breeds among the feathers of the host bird and the mites may complete their development without leaving the host. It is not necessary for these mites to stay on the host, however, and they may be found in nests or roost areas, and in surrounding cracks and crevices. They can survive for two or three weeks away from the host.

This mite may bite man, causing some annoyance. There are reports of it causing a dermatitis, but they do not appear to be as frequent as reports of dermatitis from the chicken mite. The most frequently reported trouble is irritation from the occasional bite inflicted by wandering mites. The source of the infestation may be quite varied, for this mite is a general parasite of birds, found on domestic fowl, sparrows, swallows and many other species. It is found throughout the temperate region. Annoyance of man is frequently associated with the death or departure of the normal host bird leaving an infestation of mites behind in the next area without a convenient source of food.

Tropical fowl mite: This mite is very similar to the northern fowl mite, but is found more frequently in tropical regions. It has not been reported often or from a wide area.

Migrating from Rodents

Tropical rat mite: This mite is associated with rats throughout the United States. It will feed on man and many other warm-blooded animals. The bite on man is painful, causing intense itching and a skin irritation known as "rat-mite dermatitis." The mite has not been proved to be a transmitter of typhus or other diseases, although its habits appear to suit it well for such a role. The attack on man is almost always associated with rats in buildings, and complaints are common from areas which may be infested with rats, such as warehouses, stores, theaters, and apartments. Killing of rats may intensify the attack on man, but this mite will bite man even where there is an abundance of rat hosts on which they can feed. The mites drop from their host after each feeding and may be found on a variety of surfaces near rat-infested areas. They can survive for several days without a blood meal.

Mouse mite: This mite in the United States is primarily a parasite of mice. It tends to leave its rodent host to wander throughout buildings and bite man.

Its major importance is that it has been identified through the observation of Charles Pomerantz, as the vector of rickettsial pox, a mild and nonfatal disease of man.

Migrating from Food Materials

Grain mite: The grain mite is commonly found infesting all types of grain and flour. It also may be found on other stored foods, being one of the mites reported from cheese. It prefers a moist location and under favorable conditions develops rapidly and in great numbers, completing its cycle in as little as 17 days. Under adverse conditions it may lengthen this period a great deal. The second nymphal form may be replaced by a special stage known as the "hypopus" does not move much under its own power, but it is transported from place to place by clinging to small animal forms such as insects or mice. When it encounters favorable conditions it sheds its skin and resumes normal growth and development. The peculiar adaptation through the hypopus stage makes it very difficult to eradicate this mite.

The grain mite and related mites are reported to have been the cause of mild dermatitis in man, known under various names as "grocers' itch," "vanillism" (from infestations on vanilla beans), and "copra itch." These cases are reported where products infested with the mites are handled by man. These mites are not blood-sucking forms and thus are the cause of only mild irritations, very easily remedied once the source of exposure to them in large numbers is eliminated.

Mushroom mite: This mite is a common pest of mushroom beds, but it also may be found in huge numbers on such materials as cheese, dried meats, cereals, and many other materials found commonly in homes or food storage. As with the grain mite, it is not a blood-sucking form, and any dermatitis from it would be a somewhat superficial irritation easily eliminated with the destruction of the source of the infestation. This mite is capable of reproducing in enormous numbers and may quickly overrun an entire area surrounding its source of food.

Migrating from Other Vegetable Materials

Straw itch mite: The straw itch mite normally lives on other insects. Common hosts are the larvae of several insects such as the wheat joint-worm; the wheat straw-worm; the Angoumois grain moth; the rice, granary, bean and pea weevils; the pink bollworm. It reproduces rapidly and in enormous numbers. This mite has an unusual development. The eggs hatch within the body of the female and the young are matured within the body of the mother. They are born as sexually mature adults. It is reported that a single female may give birth to over 200 adult mites and that in one week the females of this brood will have produced another brood in the same manner.

Men who are engaged in threshing straw or handling grains or other material infested with the insect hosts often are overrun by these mites. Their bites produce a rashlike dermatitis which may cover large areas of the body. The rash appears in about 12 hours after the attack and is accompanied by a severe itching. The attack is often of such intensity as to induce vomiting, headache, sweating and fever.

The attack of man by this mite was common years ago when it was the custom to sleep on straw mattresses, but in recent years reports have been relatively infrequent. An interesting report was given this year of the recurrence of this mite as a pest of man in Ohio and of the association of this problem with the appearance of a heavy infestation of wheat joint-worm in Ohio wheat for the first time in 30 years. The most striking case was that of 4-H club boys showing their animals at country fairs when they became infested from the straw which they were using to bed their animals and on which they themselves were sleeping.

Furniture mite: This mite is a common pest of furniture in Europe and has frequently been intercepted on shipments from there. It is common in this country but we have no record of it as a household pest. It feeds on vegetable matter, apparently having a particular liking for certain materials used to stuff furniture. It is very similar to habits of the grain mite. It does not feed on blood, but has been reported to be the cause of "grocers' itch" in the same way as the grain mite.

Migrating from Outdoor Vegetation

Chiggers: Chiggers which attack man are the larval stage of a mite. The species commonly encountered in the United States is *Eutrombicula alfreddugesi*.

These mites are distributed over approximately the eastern half of the country. They are most common in the southern states but frequently are abundant during the summer in the more northern states. They infest a variety of areas ranging from those overgrown and brush to well-kept lawns.

Adults of the mite overwinter in earthern cells in the soil. This stage does not attack man, but is a scavenger living on decaying matter. In the spring these adults emerge from the soil and lay their eggs. These hatch into tiny oval orange-colored larvae. It is this form which attacks man. Normally these larvae live on snakes, turtles, rabbits, birds and other wild life. They also feed on man and domestic animals.

These larvae can barely be seen with the naked eye. They are very active and crawl about rapidly in search of a place to feed. When man comes in contact with vegetation infested with these larvae they may swarm over his body. It may be several hours before they settle down to feed. Their attack seems to be concentrated at points where the clothing is pressed against the skin, as under belts or garters. They attach themselves, frequently near a hair follicle, by their mouthparts and first pair of appendages. In feeding, the mite injects into the host a fluid which liquifies the immediately adjacent tissues. The liquified tissues are ingested by the mite. The surrounding tissues become hardened, and, as feeding progresses, form a tiny tube through which further liquified tissue may be withdrawn. The larva becomes fully fed in four to six days when it drops off the host, leaving behind the tube which has developed from its feeding activity. The digestive fluid of the mite causes a severe itching and a definite dermatitis. Scratching of these areas may lead to secondary infection. The itching may last for a week or more. This mite is not associated with disease transmission in the United States.

After leaving the host the larvae transforms to a nymph and later to the adult. Neither of these forms attack man or animals, but feed on vegetable matter.

Living on Man

These mites are the true parasites of man. They are not a problem for the pest control operator. They are strictly problems for the medical doctor.

Itch mite: This mite causes scabies or itch in man. There are several closely related forms on animals which may sometimes transfer to man, but usually close contact is required and the problem is not one where the pest control industry is usually consulted or can offer any assistance of value.

Follicle mite: The hair-follicle mite of man. It lives deep down in the hair follices and sebaceous glands. It is not common in North America.

CLOVER MITES

Clover mites were first noted as a serious problem in structures in eastern United States about 1950, and since then have become a problem throughout much of the country. They are usually associated with new lawns and, therefore, are a problem mostly in new suburban areas.

Clover mites are not insects, but are related to chiggers and other mites. Clover mites often invade homes during the fall, winter or spring where they are a nuisance and may cause stains when crushed. Unlike the other mites PCO's are likely to encounter in structures, clover mites do not attack man. They do suck the juices of grasses, clover, and a variety of other plants outdoors.

Description

The mature clover mite is a reddish-brown, eight-legged creature, slightly smaller than the head of a pin. The young are smaller and redder. The front pair of leggs is much longer than the other legs and characteristically extends forward from the body. The long pair of legs can be seen with a hand lens and serve as a good way of distinguishing the clover mite from other mites of a similar size and color.

Life Cycle

The bright red eggs of the clover mite are laid singly or in masses in cracks and crevices in building walls and beneath bark on trees. Favorite spots

are the minute depressions on masonry surfaces and on rocks and wood debris on the ground. The summer is usually spent in the egg stage, but active stages may be present during the summer in cool spots in the north.

Hatching occurs between 40°F. and 65°F.; therefore, most hatching and mite activity occurs during the spring and fall. Above 85°F. the eggs remain dormant and do not hatch.

The newly hatched mites migrate to grasses, clovers, and other plants to feed. After feeding, the young mites return to their hiding places on the trees or dwellings to molt. The clover mite goes through three such molts before becoming an adult, and migrates to a food source between each molt. Each developmental stage lasts two to six days under ideal conditions. The adults migrate between the dwelling and the food source several times during their life span. Male clover mites are very rare in this country, but mating is not necessary for young to be produced. Females produce about 70 eggs each. Commonly there are three to five generations produced each year. All stages may be present during the winter. The mites hibernate in the same types of places that are used for egg deposition.

Habits

Clover mites use concealed spots in which to lay their eggs, hibernate, and hide during molting periods. Typical places of concealment are cracks and faults in concrete foundations, mortar crevices, under shingles and siding, on building paper between the walls of buildings, under windowsills, around subarea vent frames on the "in" side, and on the underside of the lower bark on trees. Eggs are also laid on accumulations of small stones, bits of wood, etc.

Most clover mites tend to move less than two feet from their hiding places to feed when food is close at hand. Therefore, feeding usually takes place closer to foundations or tree trunks.

Foraging occurs when temperatures are between 50°F. and 70°F. Remember, however, that the temperature in a microhabitat may be higher than the surrounding air temperature. On a cold winter day the south side of the house close to the foundation may be warmed enough by the sun to stimulate clover mites to seek food.

When the hiding places of the mites become warm enough to stimulate activity, the mites begin to move, perhaps in search of food. Such movements of mites hiding within the walls of the buildings may bring the mites in contact with the warmer air of the interior of the house. They apparently move towards this warm air and enter the interior of the house through cracks along baseboards, doors, or windows. This may occur periodically throughout the winter (especially on the south side of buildings), where temperatures in the hibernating places become high enough to stimulate activity. Activity is greater in the spring and fall, but as outdoor air temperatures become more favorable, there is less tendency for the mites to migrate to the interior of the building.

Feeding

Clover mites feed on grasses, clovers, and some other plants (both desirable and weed species), around buildings and on lawns. Although white clover is a highly preferred food in some places, Kentucky bluegrass, bentgrass, red fescue, red top, and chickweed seem to be preferred in most situations.

Lush lawns which are well fertilized, especially with organic fertilizers, tend to have larger populations. As lawns become older, clover mites are less of a problem. It is not known if this is due to a poorer lawn care program, different nutrient levels in the food plants, a build-up of natural predators, or a combination of these and other factors.

Clover mites feed by puncturing the plant tissue and sucking out the juices. Grass may be "silvered" by extraction of chlorophyll. Feeding usually occurs when the temperature is between 50°F. and 70°F. The time of day feeding occurs varies with the season and temperature. Late fall and early spring feeding occurs on grass, etc., growing in sheltered spots near foundations or other protected spots warmed by the sun. PCO's should observe tufts of plants in such sheltered spots for indications of clover mite problems.

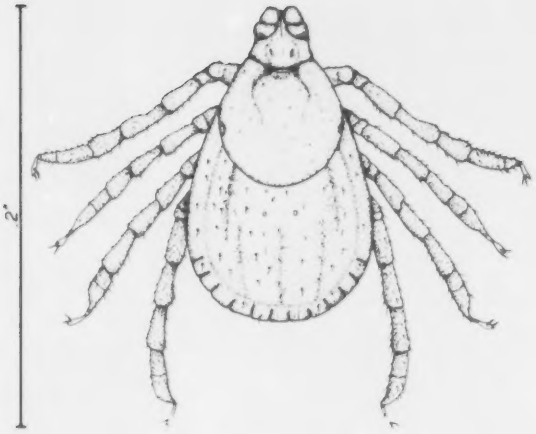
Economic Importance

Clover mites are, for the most part, nuisance pests. Their mouthparts cannot pierce human skin and they do not feed on clothing, draperies, curtains, rugs, parts of a structure, or foodstuffs. If crushed, they leave stains on walls, curtains and other materials.

They do not ordinarily attack plants within a dwelling and they usually do not do enough damage to lawns to warrant control for this alone.

They are transported in a variety of ways such as by wind, in new sod, and on new plants. They may migrate from a neighbor's lawn.

BROWN DOG TICK



If you receive calls about many small brown "insects" crawling on carpeting, walls, and sometimes furniture, and the customer has a dog, these "insects" are probably brown dog ticks. The brown dog tick is found throughout the United States. The tick is active all year, but most of your calls will come in the fall. In the United States this tick rarely attacks man.

Description and Life History

The adult male is flat, about one-eighth inch long, and uniformly red-brown with tiny pits scattered over the back. It does not enlarge as does the female.

The adult female before feeding resembles the males in size, shape and color. As the female feeds, she becomes engorged and up to one-half inch long, one-fourth inch wide, and one-eighth inch thick. The legs, mouthparts, and shield (small area immediately behind the head), remain red-brown, but the

enlarged portion of the body becomes gray-blue to olive.

The red-brown color is distinctive and no other tick you'll encounter will be uniformly red-brown.

The tiny eggs are dark brown and laid in masses. The larva is seldom seen because of its small size one sixty-fourth inch. It has only six legs (as do all tick larvae) and is light brown.

The unengorged nymph resembles the adult female, but is only one twenty-fifth inch long. After feeding, the body is smooth, shining, blue-gray with a pink tinge in some, and one-eighth inch long.

In the United States the brown dog tick feeds almost exclusively on dogs. Each active stage sucks blood from the dog, but drops off between stages to molt and finally to lay eggs.

Life History

The engorged female drops from the dog and begins egg laying about three days later. Within three or four weeks she may deposit a few hundred or as many as 5,000 eggs (1,600 is average). They are usually laid in batches between boards, under plaster or carpeting, or in cracks and crevices. The female then dies. The eggs usually hatch in three weeks although several months elapse if it is cool and/or dry.

After emerging from the eggs, the larvae move to the lower parts of walls where they wait for a dog. They can live eight months while doing so. When a dog brushes against them, or lies down near them, they crawl on and begin to feed. Ticks, (larvae, nymphs, and adults) feed only on blood. They may attach anywhere on the dog, but they are most often found on the ears and neck. The larvae feed for about three days and then drop off.

One or two weeks after the larvae have had their blood meal, molting occurs and the nymphs emerge. They may live as long as three months awaiting a dog. The nymphs feed for four days, and then drop off to molt.

The adults emerge about two weeks later. They can live as long as one and one-half years without feeding but they must feed before mating. After mating, the female completely engorges herself with blood and then drops off to lay eggs.

How Infestations Start

The ways a residence can become infected include:

1. The family dog picks up ticks from an infested residence and brings them home.
2. The family dog picks up ticks from an infested boarding kennel, veterinarian's office, or similar place where other dogs are kept.
3. An infested dog visits the residence and some ticks may drop off. In this case, a residence may become infested even though a dog is not kept there.
4. Outdoors, a dog could pick up ticks which dropped from another dog. This is unlikely in most of the United States because brown dog ticks don't survive low temperatures and outdoor populations seldom are of any significance.

Dogs do not get brown dog ticks directly from other dogs. A tick feeding on a dog drops off and molts before it attaches to another dog.

SPIDERS

Many people fear spiders because of myths that surround them, or the publiclity that has been given to the very rare fatal poisonings by a few species. Others object to these creatures because of their annoying habit of building webs in corners, on furniture, or across doorways and in other places. Under some conditions, spiders are considered beneficial because they feed on insects to which they are distantly related.

Description

Spiders have a characteristic appearance recognized by most people. Their eight legs immediately separate them from insects, which have only six. Spiders lack wings and antennae. Their bodies have but two regions—a cephalothorax (fused head and thorax) and an abdomen. Young spiders, or spiderlings, resemble the adults except for size and sometimes coloration. Males are usually smaller than females of the same species.

The eight legs of a spider are attached to the cephalothorax which also bears the eyes and mouth parts. Most spiders have eight eyes, but some species

have only six, and a few have less or none. All spiders have a pair of jawlike structures (chelicerae) at the end of which is a hollow, clawlike fang. Each fang has a small opening in the end through which venom can be ejected.

The abdomen of spiders contains their reproduction system, the largest part of their respiratory system, and the spinnerets. The latter are the silk spinning glands and are located at the tip of the abdomen.

Spider Bite

Spiders are seldom aggressive towards humans and usually bite only when injured or trapped. Only the large spiders are capable of breaking the tough skin of a human being; the smaller ones can inflict only superficial scratches.

Nearly all spiders have venom glands, but almost all of the United States species have a venom so feeble that its brief effects are insignificant.

The severity of a person's reaction to the bite of a spider is influenced by a number of factors. The species of spider and the area of the body where the bite occurs are of great importance, but the amount of venom injected, depth of bite, seasonal changes and temperature, also play a role. The signs and symptoms are caused by the mechanical action of the bite, and/or by the venom. In some cases there is no reaction at all.

Injury caused by a bite is partly mechanical and partly due to the injection of venom which is irritating, but in most cases is not toxic. Symptoms are slight soreness and itching similar to a mosquito bite or burning, throbbing, numbness, stiffness, and sometimes a very slight swelling.

Life History

After being impregnated by the male, the female spider begins to lay eggs. The eggs are laid in dark retreats or in silk cocoons called egg sacs. The females of some species guard the eggs, other species carry the egg sac with them. Depending upon the species, a female may produce as few as two, or as many as 3,000 eggs. They are usually laid over a period of time in a series of several sacs.

In warm weather, the young may hatch within three weeks. They tend to remain together for several days before scattering. Cannibalism often occurs during this period. Most of our common species mature within one year, going through a series of molts as do insects. Some species require up to 20 years to reach maturity.

Mating and egg-laying occur anytime of year, depending upon the species. Some species, after overwintering as half-grown individuals, mature and lay eggs in the summer. Others overwinter as eggs, hatch in the spring and mature and lay eggs in the fall.

Habits

Spiders cannot fly and, therefore, use other means of dispersing—in addition to walking. Some, such as the brown recluse, find many objects transported by man suitable retreats, and can be moved great distances in this manner. The most interesting method of travel is "ballooning," which is practiced primarily by the young of some species. To accomplish ballooning, the spider climbs to the top of an object such as a plant or fencepost and releases a strand of silk. If a wind is blowing, the spider sends out silk until there is enough of it windborne to lift the spider from its perch. Spiders reach great height by this method and are known to have been carried for distances as great as 60 miles.

Some spiders build simple webs and other build very complex webs. Webs usually consist of strong, nonsticky strands of silk which form the framework of the web. These strands are united with a series of silk strands having sticky globules on them. The spiders are just as susceptible as insects to being stuck in the sticky globules, but the spiders are adept at avoiding them. Some types of spiders do not spin webs, but use their silk only for building egg sacs or retreats.

Feeding and Moisture Requirements

Spiders can be separated into two groups based on the way they capture prey: (1) the cobweb spiders, which make webs to catch insects and live all the time in the web or in a nest near it; (2) the hunting spiders, which run on the ground or on plants, catching insects wherever they find them, or waiting among leaves and flowers until insects come within their reach. The species that commonly live indoors are cobweb spiders.

Brown recluse spider: The brown spider is a soft-bodied, secretive species often found in homes and capable of inflicting venemous bites. Adults vary from three-tenths to one-half inch in length; the average is about four-tenths inch. Males are usually slightly smaller than the females. Their color varies from yellow to dark brown, with the cephalothorax (that portion of the body bearing the legs and eyes—a combined head and thorax) usually being lighter than the abdomen. Legs are long and well covered with short dark hairs.

Distinguishing characteristics are the presence of three pairs of eyes arranged in a semicircle on the forepart of the head, a violin-shaped dark marking immediately behind the semicircle of eyes; and a somewhat flattened carapace (hard shell covering cephalothorax) with a distinct short median groove. The immature stages closely resemble the adults except for size and often a slightly lighter color.

Life cycle and habits: The eggs are deposited in off-white round silken cases, approximately one-third inch in diameter. These cases are found in sheltered dark areas in the spider's habitat. In the summer, young spiderlings emerge from the egg in 24 to 36 days. However, they have hatched from the egg sometime earlier and molted once before leaving the egg case. The abandoned egg case contains the cast skins of the first instar spiderlings. Fifty or more spiders usually emerge from the egg cases. Development is relatively slow and is greatly influenced by weather conditions, and the availability of food. With adequate food and mild temperatures, this special can reach maturity in seven to eight months. The spiders are capable of surviving for long periods of time without food or water, up to nearly six months in some tests conducted by the Entomology Department, Oklahoma State University.

The brown spider has been reported from states including Kansas, Missouri, Arkansas, Texas, Louisiana, Mississippi, Alabana, and Tennessee. It is usually found indoors in all types of buildings; and when in homes, particularly in bathrooms, bedrooms, closets, garages, basements, and cellars. It can be found hiding in old clothes, on the underside of tables and chairs, behind baseboards and door facings or in corners and crevices. The web is not elaborate and is best described as an off-white to grayish nondescript "cobweb" type of webbing.

Spiders eat live prey which almost always consists of insects and their small relatives. Victims are killed by the venom which the spider injects through its fangs. Spiders have food preferences, but a hungry spider will tackle most anything that is not too large. Some, if not all species, can go for long periods without food. The brown recluse, for example, has survived for six months without food or water.

Although all spiders require water for survival, some species require very little and can live in dry environments. Many species, however, can live only in humid places and need a regular source of drinking water. Most species are attracted to water sources if such are available. For this reason, you should first look in areas around water pipes, floor drains, and airconditioners when trying to determine the source of an infestation indoors.

Habitats

As indicated above, many spiders are associated with moisture and therefore, are found in basements, crawl spaces, and other damp parts of buildings. Others live in warm dry places and can be found in subfloor air vents, in upper corners of rooms, and in attics. Most species found indoors hide either in cracks, in darkened areas, or in retreats they construct of silk. The indoor species build webs.

Outdoors, spiders live in a variety of places depending upon the species. Some hide in flowers waiting for prey. Others live on tree trunks, under stones or leaves, or in bushes. Some often live around buildings, beneath shingles or under the eaves. Most of the outdoor-living species don't adapt to indoor conditions, although some of these species can live in attics.

Dangerous Spiders and Their Occurrence in the United States

Few dangerous species of spiders occur in the United States. You need to be especially aware of the widow spiders of the genus *Latrodectus*, and the brown recluse spider and its relatives of the genus *Loxosceles*. Deaths of humans have been recorded from bites of spiders of both groups. Other species of spiders may bite humans and cause irritation. These bites rarely cause serious reactions, but they can become infected.

The web is not used particularly for catching food, since this spider is a hunter rather than trapper, but more as a place to "hang its hat." The spider is not aggressive and usually runs for cover when disturbed. Most bites occur when a person crushes the spider when putting on old clothes that have been hanging in a garage or by rolling on the spider in bed while asleep.

Brown recluse spiders live both outdoors and indoors. In Oklahoma they find shelter under stones, boards and other objects. You may also find them against foundations and in crawl spaces. Individual spiders are outside even in winter.

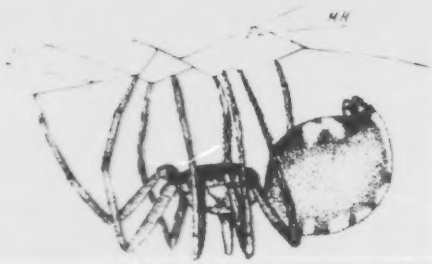
Brown recluse spiders show a preference for concrete-block buildings, although you may find them in all types of buildings. They hide in cracks, crevices and other dark recesses. They favor storage areas such as closets and attics. Unoccupied houses vacant for short periods are not notably lacking in brown recluse spiders. However, lofts of resort cabins vacant for four or five months at a stretch commonly have infestations. Grain bins commonly have these spiders.

Infestations have become a problem for utility companies, whose transformer boxes and electrical switch gear often shelter the spiders. Station and line maintenance personnel should become aware of the spiders and the dangers associated with them. In areas known for spider populations, you should contact utility companies to offer your services.

Effects of the bite. The victim may not be aware of being bitten for two or three hours, or a painful reaction may occur immediately. A stinging sensation is usually followed by intense pain. A small blister usually rises and a large area around the bite becomes congested and swollen. The victim may become restless and feverish and have difficulty in sleeping. The local pain is frequently quite intense, and the area surrounding the bite remains congested and hard to the touch for some time. The tissue affected locally by the venom is killed and gradually sloughs away, exposing the underlying muscles. The edges of the wound thicken and are raised while the central area is filled by dense scar tissue. Healing takes place quite slowly and may take six to eight weeks. The end result is a sunken scar which has been described as resembling a "hole punched or scooped from the body." Scars ranging from the size of a penny to half-dollar have been reported.

In the case of a bite, the victim should immediately consult a physician and, if possible, bring along the spider which caused the bite for positive identification.

The widow spiders:



The most common and most dangerous of all the widows is the black widow, *Latrodectus mactans*. The black widow is decreasing in importance as a dangerous spider because fewer outdoor toilets are in use today and this is where many of the bites occurred.

There are several subspecies of this spider and some authorities recognize *L. variolus*, the "northern" widow, as a separate species. All of these widows are potentially dangerous and for practical purposes, you do not need to be able to distinguish among them. Death results in about 5 percent of the untreated cases of black widow spider bites.

Description. The female black widow is shining jet black on the upper surface of the body. On the underside of most specimens is the characteristic red mark shaped like an hour glass. Some specimens have this mark divided into two spots. There may also be one or more red spots above the spinnerets near

the tip of the abdomen. The body of a full-grown female is about half an inch in length, but the body of the male is only one-seventh or one-sixth of an inch long. Only the female widow is usually considered to be dangerous, but the bite of a male may be hazardous to a small child or a very sick person.

Habitat. The black widow may enter residences, but is usually found in garages, sheds, outdoor toilets, culverts, and similar places. Its web is loosely woven and irregular, and at or near ground level. Some of the subspecies tend to live away from man and build webs several feet from the ground.

There are two other species of widows which are less dangerous and found only in Florida. They have similar habits except they tend to live off the ground in trees or shrubs.

SCORPIONS

Scorpions are a small order of animals which belong to the class Arachnida along with ticks, spiders and mites. There are only about 50 species in the United States. Most of these are found in the Southwest. Scorpions are rare north of a line through Baltimore, St. Louis, Salt Lake City, and San Francisco.

Description

Unlike other arachnids, scorpions have an elongate, segmented abdomen which ends in a stinger. Like other arachnids, they have four pairs of legs and these and the large pincers arise from the combined head and thorax (called the cephalothorax). The stinger, and not the pincers, contains venom. In the United States, most species of scorpions are nonlethal and are black, brown or gray and range in length from one-half inch to seven and one-fourth inches.

Only two species in the United States are considered highly dangerous, *Centruroides sculpturatus* Ewing, and *C. gertschi* Stanhnke. Their distribution in this country is limited to southern Arizona. They can be recognized by their greenish-yellow, lemon yellow, or straw color, and a spine at the base of the stinger. *C. sculpturatus* is uniformly yellowish and may grow to a length of three inches. *C. gertschi* is the same size, but has two irregular blackish stripes along its upper surface. Both of these scorpions are very slender

Habits

Scorpions are dry land animals and are not normally found in watery or swampy areas. They do require moisture, however, and are attracted to damp areas such as around condensers and evaporators of air-conditioning units.

Scorpions usually hide during the day and come out at night to feed and mate. A few species burrow, but most species live about ground and hide beneath stones, logs, boards, rubbish, loose bark on trees and posts, and in crevices between the bases of palm tree leaves. Scorpions wander, especially during early summer, and often enter houses.

In houses, they are most commonly found in crawl spaces and attics, but are also attracted to kitchens, bathrooms, and other rooms where water is available. They will also hide in shoes, clothing and bedding.

Although scorpions are found in the warm areas of the country, they do not like temperatures about 90°F. to 100°F. When attics and similar places get hot, the scorpions there will be driven out and they will move downward into the living quarters of the structure.

Feeding

Scorpions feed on small spiders and soft-bodied insects. They will eat other species of scorpions and small individuals of their own species. Scorpions have poor eyesight so they do not stalk or chase their prey, but lie in wait for it and grab it with their pincers. Small insects are eaten immediately, but larger prey are stung and eaten after they cease to struggle.

Public Health Importance

Scorpions rarely sting man, and then only when provoked. Few species are deadly. However, all scorpion stings should be considered dangerous.

Most ground scorpions inject a toxin which destroys red blood cells, but which is only rarely, if ever, fatal. The venom produces a localized reaction (painful swelling and discoloration at the site of the sting), which may be followed by mild generalized reactions (semiparalysis of the tongue).

The two highly dangerous species in the United States inject a venom which primarily affects nerve tissue, and which may cause death. The venom produces a generalized reaction (numbness near site of sting, nausea, tightness of throat muscles, salivation, sweating, semiparalysis of the tongue, vomiting, restlessness, cyanosis, and sometimes death). There is little swelling or discoloration at the site of the sting of our two dangerous species. The very young and the very old seem to be the most susceptible to scorpion venom, but deaths have been recorded at all ages. There also seems to be seasonal variation in the potency of scorpion venom, and susceptibility to scorpion poison is extremely variable, even among individuals of the same age; hence, all scorpion stings should be treated by a physician immediately.

Sanitation

Loose boards, rock piles, wood piles and trash, should be removed from around the building to eliminate harborages. Lumber and fire wood should be stored off the ground. The elimination of German roach populations and other insect infestations in and around the building will make the area less attractive to scorpions.

SELF-HELP QUESTIONS ON ARTHROPODS OTHER THAN INSECTS

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. Describe the one characteristic of the following arthropods which help identify their presence. Also list their damages around the home and contol?

   a. Sowbugs and pillbugs

   b. Centipedes

   c. Millipedes

   d. Clover mites

2. Which of the following mites attacking humans may cause dermatitis?

   a. Northern fowl mite
   b. Mouse mite
   c. Tropical rat mite
   d. Chicken mite

3. Explain the egg to adult development of the Grain mite?

4. What is grocer's itch?

5. What is a chigger and where can their feeding be most intense?

6. How is the brown dog tick spread from animal to animal?

7. Define a spinneret and ballooning?

8. What is the maturity time of a spider from egg to adult?

9. What are the two types of spiders and how do they differ in feeding habits?

10. What are the two types of dangerous spiders and how do adults differ?

VERTEBRATE PESTS

SNAKES

Snakes of many kinds find their way into and under buildings, suburban yards, rock gardens and walls, poultry houses and outbuildings, and thus become a problem for the pest control operator. They are active in warm temperatures (usually daytime) and hibernate during the winter in burrows and dens.

Typical signs of snakes are their shed skins and droppings. Snake droppings, like bird droppings, usually have white material at one end. Snakes are important to the pest control operator in that they frighten humans, bite, kill birds, and cause odors in warm weather.

MOLES

Problem Areas

Moles cause problems in lawns, golf courses, gardens, and cemeteries.

Objectional Characteristics

Burrowing is one kind of damage moles cause; this includes mounds, holes, runways, and garden damage. They open runways through which meadow mice reach and damage bulbs, flowers and vegetables. Shrews also may use their tunnels.

Habits

Moles are subterranean; they rarely come above ground. They construct permanent runways along fence rows, borders and other protected areas—plus feeding tunnels which are constructed at random. Moles may burrow under shallow foundations, concrete floors and walls. They have been reported to burrow 100 yards in a single night. Moles breed in the spring and have one litter of three to six young.

Natural Food

Moles eat earthworms and beetle grubs and other soil insects. In 24 hours a mole may eat more than its body weight in earthworms.

Signs

Signs of moles are their mounds and runways. Moles have fine teeth with which they may tear, but cannot gnaw, plant stems or roots. The mounds are built up like a volcano—through a central shaft. Mole runways are about one and one-half inches in diameter and only a few inches below the surface.

BATS

Description

The bodies of bats are covered with fur. Their wings are a leathery membrane stretched between the greatly elongated bones of their front legs and toes and extending, in most species, back along the sides of the body to the hind legs and tail. Bats are the only mammals that can fly.

Habits

Bats roost singly or in groups during daylight in sheltered spaces. In warm weather they are active from dusk to just before dawn. All bats in a roost leave within a few minutes of each other. Scent on a roost remains attractive to other bats for a long time—possibly years. Some migrate south in the colder months.

Bats have easily adapted themselves to living in buildings, where they roost in attics, wall voids, summer cabins, basements, theaters, unoccupied structures and older residences. Their presence may be easily recognized by their segmented droppings. They are readily distinguished from rodent droppings as they consist of insect fragments. In addition, grease spots at entrances and roots, noise, and odor from urine and droppings are good indicators of a bat infestation.

Feeding

Bats feed on live flying insects.

Precautions

Never handle bats, dead or alive. They have needlelike teeth and can bite severely. Bats may be rabid and any bat which acts in an abnormal manner such as fluttering around on the ground should be avoided or handled with tongs.

Any bat causing a bite should be captured with brain intact for examination by health authorities. Use beekeeper's helmet, gloves and coveralls when treating roost areas.

RATS

In the United States there are two common species of rats, the Norway (brown or sewer) rat, and the roof (black or ship) rat. The Figure above shows the differences between them as well as the means for distinguishing young rats from mice. Before any attempt is made to control these pests, a thorough understanding of their habits and habitat is necessary.

Description

The Norway (brown or sewer) rat is found in every state in the Union. It is usually brown above and lighter colored beneath. Large specimens may measure twelve to eighteen inches from nose to the tip of outstretched tail, and may weigh over a pound. They normally stay close to ground level and prefer to nest

in burrows in the soil. The Norway rat is equally fond of fruit, vegetables, meats and cereals. Their droppings are about three-eighths to three-fourths inches long and are spindle shaped, i.e. rather pointed at both ends. Norway rat droppings may be found along runways, but are most frequently found where these rats stop to eat.

The roof (black or ship) rat is found only in the warmer parts of the United States. It is black or tawny and may (or may not) be lighter colored beneath. They are smaller and more slender in build than the Norway rat, with tails longer than their bodies. Ordinarily they nest in buildings above the ground level and are seldom found in the same building with Norway rats. They prefer fruit and vegetables as food. The droppings of the roof rats are about three-eights to one-half inch long and are sausage shaped, i. e. blunt-ended. They are scattered wherever the roof rat travels.

Habits and Habitat

Rats must have a place to hide during the day, and they cannot multiply without a place to nest. You should discover these harborages and nesting places, if at all possible.

Most buildings have double walls with spaces between them, and similar spaces between floors and ceilings. These are common hiding places for rats. Of course, improperly built shelves, cabinets, and work tables, cupboards, pantries, etc. all provide space under and behind them just suited to a rat. Piles of stored goods provide many rats with homes, especially if these are against walls and on floors. Such preferred hiding places should be located and noted, as they will certainly be part of your problem.

Roof rats prefer to nest high in a building and will usually be found in attics rather than basements.

Burrows in soil are the preferred nesting place of the Norway rat. Since many buildings have exposed soil in basements, cellars and crawl spaces, an inspection of a building is never complete without a thorough check of all the area under the first floor.

Economic Importance

Rats eat almost everything used as food by man and livestock. With their dropping, their urine or their dirt and hair, they contaminate much, much more than they eat. Such products must be destroyed or sold at a loss. Damaged packages must be repaired or replaced.

Damage is usually easy to find—in fact, it will probably be pointed out by the customer. Gnawing damage is caused by the rats in their attempts to get food, to get nesting materials, to get through a barrier or simply to sharpen their teeth. In search of food, they tear open boxes, cartons, sacks, or other wrappings of food. When making a nest, female rats may tear up anything useful such as paper goods, sacks, rags or even clothing and furniture. Holes may be gnawed through walls and under the edge of doors. Wood and plaster are easily penetrated as are many other similar building materials, especially if an edge is available for them to chew on.

To and from the damage you will probably find trails or runways going to the rat's hiding place, unless the infestation is quite recent. These runways are nearly always along walls, as rats do not like to go out into the open. Look for tracks and tail marks in dust. Greasy smears, dark in color, show up where rats rub their bodies repeatedly. These are especially likely to show on steps and on the underside of the ends of floor joists in basements. Hairs will seldom be found except in tight places where the rats must squeeze through.

Droppings are usually easy to find and generally represent the favorite feeding places. Rats often carry food to a protected spot in out-of-the-way corners to eat it. Droppings accumulate in such spots, and the presence of fresh, soft, moist, glistening droppings will tell you that rats have been there very recently. Old droppings will generally be dry; or, if in a moist place, will probably be moldy. In any case, they will likely be dull in color.

Indicator Tracking Powder

One of the best means of getting evidence of the presence of rats is to use some form of indicator tracking powder which may be applied along suspected runways and feeding areas. Any easily available safe material, such as flour or talc, may be used for this purpose. Flour should not be used where insects must also be controlled because it will be attractive to and food for a great variety of insect pests.

Feeding

Rats eat the same type of food that we eat, and for practical purposes must be able to eat every night. In looking over a rat control job, you should not only find out what and where they are eating, but also consider whether it is possible to get all food out of their reach. If you can, it will make a poisoning job much easier.

The importance of water to rats is often overlooked. They will drink from any—even the dirtiest—source of water. Ice box drip pans, uncovered toilet bowls, uncovered sewers with water traps, undrained kitchen sinks, laundry tubs, flower-watering pans, watering pans for pets, and fish bowls are just a few of the common sources of water for rats in buildings. Where there is no source of water for rats inside a building, it may be assumed the rats have a source outside the building, even though they feed and hide in the building.

Entrances

Finally, you must check the building to see if rats are going, or can go, in and out of the building. If the building furnishes food, water and hiding places, the rats in it may not be going in and out. If it does not supply all three of these needs, you can be sure they have access to what they require outside the building. Even though your immediate job be only to get rid of the rats in the building, you should know if the building is rat-tight or not, for future reference.

In checking the building for rat-tightness, remember that young rats may enter any hole more than one-half inch in diameter; both Norway and roof rats are good climbers, and both are surprisingly good jumpers. Norway (brown) rats are also excellent diggers.

Rats generally enter through open doors, open windows, and uncovered sewer drains. These entrances require no effort on the rat's part. Openings around utility pipes, such as water, gas and drain pipes, are also easily found by rats.

The Norway (brown) rat so commonly runs through sewers that many people refer to it as the "sewer rat." It will dive through a sewer trap filled with water, and only tight sewer drain covers will stop it.

If such rat openings are not waiting for them, rats will gnaw through wood, particularly at the corners of doors and cellar windows. They can usually

tunnel under shallow foundations and readily climb rough walls or inclined pipes and wires to reach entrances above ground level. They have been known to climb vertical pipes, gutter drains and the like which are close to an outside wall.

HOUSE MOUSE

Description

The house mouse is a small, dark gray rodent. When full grown its body is about three inches long and its tail is about the same length. Although young Norway rats are sometimes mistaken for adult mice, the two are easily distinguished. Note that the tail and body of the house mouse are about equal in length, whereas the tail of the Norway rat is definitely shorter than the body. The drawings also show that the grown house mouse is well-proportioned while the young rat, like most baby animals, has a head and feet which seem too large for its body.

Habits and Habitat

An important habit of mice is that of staying close to their supply of food. If they can find a nearby nesting site, they may never travel more than a few feet from their birthplace. This very limited range in their activities is due to their retiring nature and because they do not require as much water as do most animals. They usually obtain all the moisture they need from their food.

Favorite nesting places for mice are in hollow walls, ceiling spaces, under or behind cabinets and similar enclosed spaces. Voids in or between stored materials, particularly sacked feeds, are choice home sites for mice.

Runways are not as easily found as are rat trails. They do, however, tend to follow regular paths along walls. Normally mice travel these paths in short runs from one protected spot to another with a short stop at the end of each run to see if the coast is clear before starting another run. Mice are capable of getting through surprisingly small openings. A baby mouse can go through a hole about one-fourth inch in diameter, while a three-eighths inch crack, under a door, for example, will permit an adult mouse to pass.

Much mouse damage is due to their collecting soft materials for nest lining. They are particularly inclined to chew up paper and to chew holes in furniture upholstering and other forms of cloth materials. Damage to flour and feed sacks may be very great, even though only a few mice are present.

Mouse droppings are much smaller than rat droppings and they tend to be pointed at one end, whereas Norway rat droppings are equally rounded at both ends. When abundant, mice leave a characteristic mousy smell, chiefly from their urine.

RATS VERSUS HOUSE MOUSE

The following is a comparison between the behavior of the house mouse and the behavior of rats in general. Once you have identified the rodent, a thorough understanding of its behavior is the next step toward its control. For practical purposes the behavior of the Norway and the roof rat is the same, except the Norway usually burrows in the soil and the roof rat usually nests above ground.

Territories

Rats are "social" animals and live in colonies. Several may use the same food and water sources and runways. They even nest close to one another. Rats can be controlled with fewer bait placements since they do share a food source and will travel further for food.

The house mouse is more of a "loner." Each male mouse stakes out a "territory." In each territory there are one or more females, food and shelter. The male mouse does not willingly share his territory with another adult male mouse. Mice can be controlled only with many bait placements—at least one in each male's territory—because of these territories and short distances traveled.

Distance Traveled

The rat will travel no further than he has to for food and water. He will travel 100 feet or more if necessary. In urban areas, rats stay on their own block and are usually restricted to smaller areas within the block.

The size of a mouse's territory depends upon the physical arrangement of his environment and the number of other mice in the area. The more mice, the less territory each has. The mouse may not travel more than 10 feet from his nest if

food is close by and/or if there are many mice in the area. Some mice may spend their entire lives in a pallet of feed.

Activity Periods

Rats and mice prefer to come out and feed at night and are most active at dusk. If a building is lighted in the evening, activity begins after the lights are turned off. Under continuous lights, the rodents will be active during the quietest periods. When living conditions become overcrowded for the rodents, some will be active during the day and your customer will see them. This indicates a very heavy infestation.

Feeding Habits

All rodents feed in accordance with body needs. This is influenced by temperature, amount of free water (water available for drinking) and the amount and kinds of food. Although there are exceptions, we can generalize as follows:

Rats become conditioned to eating a particular food. They approach new food with much suspicion and taste it cautiously. If it tastes bad or makes them sick, they won't eat it again. This is "bait shyness." Once the rat finds a food it likes, it will fill itself in one feeding. When baiting, you can often get effective control by using a bait that is identical to the food the rats are using. If a different food is used as bait, prebaiting with unpoisoned bait for several nights will increase bait acceptance. Rats prefer good quality food so your baits must be as good and preferably better than the rat's regular food. Top quality yellow corn meal and oats make a good "universal" bait, but no bait is best for all situations.

The house mouse is not suspicious of new foods and will eagerly sample them. This habit aids you in baiting for mice. To offset this, however, mice will go back to feeding on other foods if your bait is not as attractive. Also, they nibble. Because they nibble and feed on many different foods in one night, it is difficult to get them a lethal dose of a poisoned bait. As with rats, there is no "best" bait for all situations. Attractive baits include pineapple, prunes, gumdrops, and peanut butter.

Water Requirements

Rats require free water to drink if feeding on dry foods, such as grain. If you can eliminate their water source, liquid baits are very effective. House mice can survive long periods without drinking water. If their food contains some water, they don't need any drinking water. Water baits are readily accepted, however, and you may find them more useful than dry baits in some situations.

Reactions to Environment

Rats and mice tend to become very familiar with their environment. The mouse checks out his territory at least once very 24 hours, and the rat keeps check on the area around his nest, food and water and his runways between them. When changes occur, rats and mice react differently.

Rats are very suspicious of any changes. They approach new objects cautiously and may even avoid them the first few days. Even a change in position of familiar objects causes suspicioun. Eventually rats adjust to any change. Therefore, they may avoid your traps and bait boxes the first night or two. Since the weaker rats are usually the first to investigate a change, you will trap or kill the weaker, nonbreeding rats first. If so, all you've done is temporarily reduced the population. Prebaiting or placing unset traps ahead of time will help overcome this reaction. If possible, avoid changing anything else in the rat's environment. Changes of light, noise or other factors may upset the rat and make him very wary.

The house mouse reacts to change by exploring it immediately. He usually nibbles new baits as soon as he finds them. He will investigate traps even though they are unbaited. In fact, your control success may be increased if you make constant changes in the mouse's environment. Changing baits or the placement of baits or traps helps. Although unbaited traps catch mice, baited traps increase your success.

Movements

Rats are less suspicious when first entering a building since everything is new and they must "learn" the new environment rapidly. You can most easily trap or bait them then. Perimeter control programs work well because they intercept rats migrating into the area when they are more easily trapped or baited.

Once the rat has explored his new home and settled down, he becomes suspicious of changes and is once again wary of traps and baits. The rat establishes pathways between nest, food, and water. These pathways are along walls or objects where possible. In continuously lighted areas, the rats will move in the shadows. Traps and baits should be placed along these pathways. Sometimes you can place boxes or other objects to "lead" rats to a trap or bait. Remember, the rat may be suspicious at first.

Mice will explore large areas when moving into an environment. The territories established may be smaller than the area originally explored. To encourage mice to range farther so they will find your traps and baits, their environment should be disrupted as much and as often as practical. Palleted stacks in warehouses should be moved and/or restacked on a regular basis. Every time this is done, the mice will come out of the stacks and re-explore the area. This is the time to control them with traps or baits. Mice also travel along walls or objects and in shadows. Where studs and sills are exposed, the mice will run on the sill and go around each stud; rats will travel on the floor. Mice don't need to be "led" to traps or baits, but traps and baits should be placed along their normal pathways.

SQUIRRELS

Squirrels cause problems in attics and unoccupied areas. They gnaw cables and electric wiring, cause damage to gardens, are noisy, carry ectoparasites, bites, and their urine causes objectionable odors.

They are active in early morning and late afternoon, and store food in outdoor caches. Squirrels don't hibernate. They have a litter of two to seven in early spring, sometimes a second litter in August.

Squirrels eat nuts, corn, seeds, bark, buds, fruit, bulbs, leaves, insects, and birds' eggs.

Signs of squirrel activity include gnawed holes, nest materials, damaged corn and buds, opened nuts, droppings and tracks. Squirrels are protected game animals in many areas and are protected in some cities. Check with a game warden or other local authority before beginning a control program.

SKUNKS

Because of their odor, skunks create a particularly bad problem when they live near or under buildings. They are active principally at dusk and night, are poor climbers but good burrowers. They have a range of about one quarter mile. They mate in spring, have one or two litters of about four young. Skunks may live up to six years.

A skunk's diet consists of grubs, insects, small rodents, frogs, fruits, berries, birds, eggs and garbage. Food may be fresh or spoiled. Its droppings usually contain undigested bits of insects and seed coverings.

If a skunk is aggressive, STAY AWAY——it may be rabid. Skunks can squirt 9 to 10 feet against the wind. Their aim is excellent and they have repeating action. Traps that kill or maim, or the use of violent poisons, may result in serious odor problems.

Skunks are protected fur animals in most states. Consult a game warden before initiating a control program.

SPARROW

The English Sparrow, which is also known as a house sparrow, is an imported bird. It does not belong to the sparrow family at all, but to the Old World weaver finches. They were introduced about one hundred years ago and have spread throughout most of the United States and Canada. They resemble the true sparrows in size and in their more or less grayish-brown coloring. The male has a black throat with white cheeks. They spend much of their time feeding on the ground, and hop but never walk.

English sparrows are prolific breeders as they average about three broods per season with four to seven offspring per brood. It is characteristic of this species that both individuals and flocks operate within rather confined areas. Some may move to central areas as cities in the winter time and disperse to the country in the spring; but as a rule, the feeding, nesting and other activities of these birds occur in a very much limited area.

English sparrows compete with many birds preferred for their song or beauty. Being pugnacious, they drive the more desirable birds from nesting sites as well as from feeding grounds. Their nests are relatively large, and are not only

unsightly but often plug drains, gutters and the like and thereby cause serious damage from overflowing water. In some cases, each pair of birds makes a separate nest; but in other cases, community nests are used by several families.

The food of English sparrows is primarily seeds, but they may eat fruit, buds and emerging plants. Occasionally they eat insects, but without great benefit to agriculture.

STARLINGS

Starlings also were introduced from Europe. Since their introduction in 1890 in New York, they have spread to the Pacific Coast and even to Alaska. They are dark colored, chunky, short-tailed birds and intermediate in size between sparrows and pigeons. From a distance they appear to be entirely black, but they are actually flecked with light colors and much of their dark feathers show irridescent purples and greens. During spring and summer their moderately long bills are bright yellow. Some people confuse starlings with blackbirds, but none of the blackbirds has the short tail or yellow bill. Starlings, unlike English sparrows and pigeons, almost always feed a relatively great distance

from their roosting places. They are important predators upon many soil-dwelling insects, but will eat seeds and grain and occasionally destroy fruits.

There is ample evidence to indicate that some starlings migrate and that others do not. In the spring when the nesting season begins, the birds scatter to suburban and rural areas. They make rather coarse nests in tree holes, bird houses and the like. One egg a day is laid until an average of six or seven eggs have been deposited. Most starlings have two broods per year.

Starlings are objectionable primarily because of their habit of roosting together in large numbers on or near buildings. These roosts are the source of much noise and dirt. Since starling control is largely limited to preventing the birds from using certain trees and buildings as roosts, it is necessary to understand starling roosting behavior. Flocks to be controlled should be observed and their movements recorded. Typically, the roosting behavior of starlings is as follows. During the breeding season when the mated birds are dispersed and caring for their young, a few "bachelor" birds travel together between their roosts and feeding grounds. As the young birds of the first brood learn to shift for themselves, they join the "bachelor" birds. Later, the second brood of young and the parent birds join these roosting flocks. The great increase in the size of the starling flocks about midsummer indicates that the parents and their second brood of offspring have joined the roosts. From then until late in the fall, starlings use the summer roosts which are often in trees. It appears that deciduous trees such as the Norway maple are well suited for starlings in the summer.

Migration may occur when the birds leave their summer roosts. Those which remain in an area usually shift their roosts to city buildings which they use throughout the winter.

In their daily cycle of movement, starlings leave their roosts rapidly about sunrise. They fly in flocks over fairly well-established flight lines and for distances up to 50 or 70 miles. In the evening, those farthest from the roosts are the first to turn back so that all reach the general vicinity of the roosts approximately the same time. The time for entering and leaving roosts apparently is controlled by light intensity.

SELF-HELP QUESTIONS ON VERTEBRATE PESTS

Now that you have studied the section, answer these questions. Write the answers with pencil without referring back to the text. When you are satisfied with your written answers, see if they are correct by checking them in the text. Erase your answer and write in the correct answer if your first answer is wrong.

1. Where may snakes be expected to spend the winter?

2. What is the natural food of moles and describe their burrowing habits:

3. Describe the roosting habits of bats:

4. Can bats be rabid and what precautions should be taken in handling them?

5. Explain the identifiable characteristics and feeding habits of the Norway rat, roof rat, and house mouse:

6. Where may Norway rats and roof rats be expected to nest?

7. How may fecal pellets be identified comparing the three rodents mentioned in question No. 5?

8. What are the water needs of rats compared to mice?

9. Describe the feeding habits of mice and rats as it affects control:

10. Does control of squirrel and skunks require local permits?

11. Describe the best methods of skunk removal:

12. How do feeding and nesting habits differ comparing starlings with the English sparrow?

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